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ABSTRACT

The information contained in this booklet deals with metric measurement units. It discusses the history of the metric system and the advantages and rationale behind its use. It then provides a discussion of each of the concepts of metric measurement for area, length, volume, mass and weight, and temperature and how to implement them in a classroom for children. Games, exercises, and activities for all age groups constitute the majority of the handbook. A list of references and other resource materials are included. (MN)

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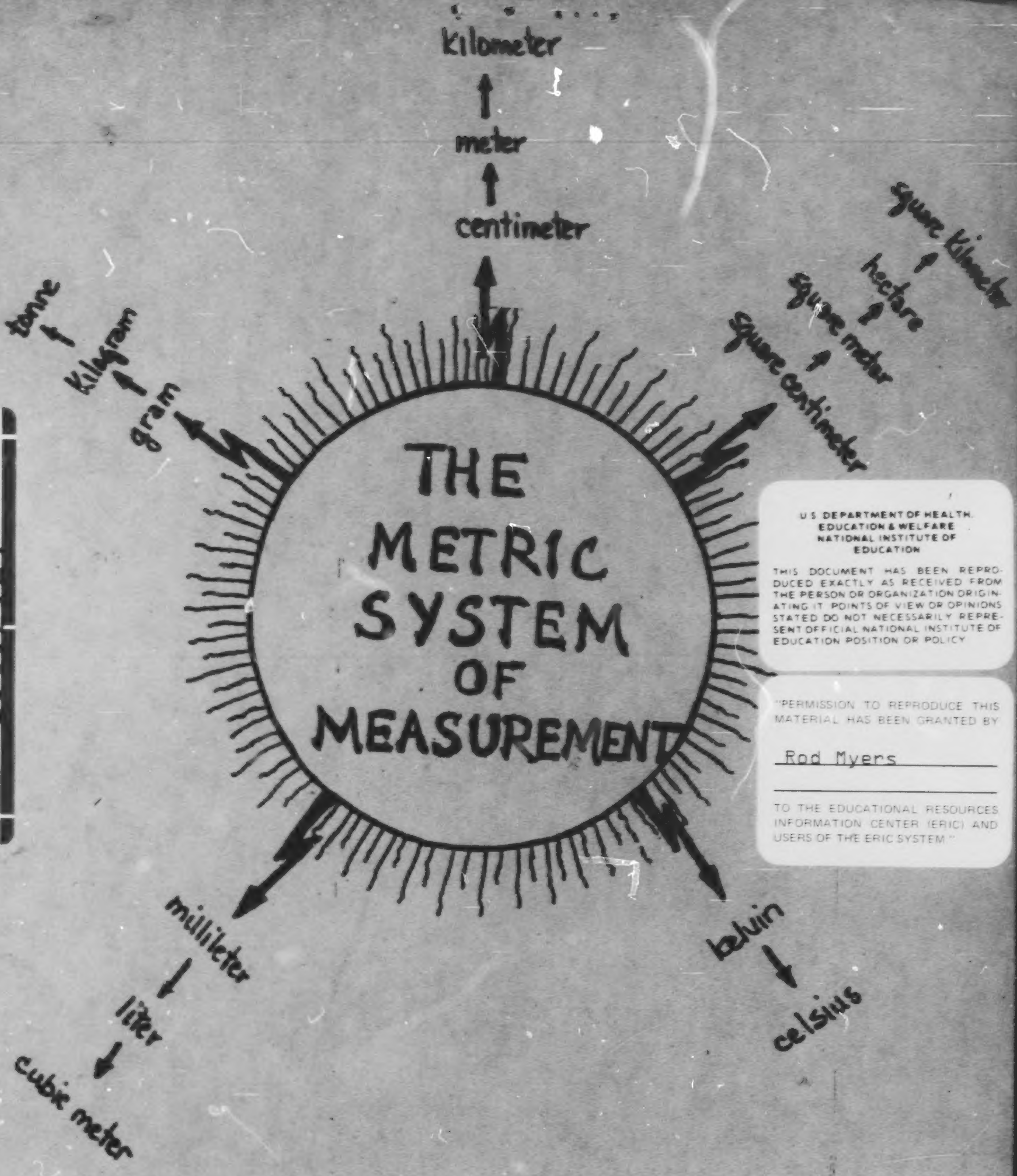
kilometer
meter
centimeter
square kilometer
hectare
square meter
square centimeter
tonne
kilogram
gram
milliliter
liter
cubic meter
kelvin
celsius

THE METRIC SYSTEM OF MEASUREMENT

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PREFACE

This booklet has been gleaned and edited by graduate students of the CI 538, Mathematics in Elementary School, SS, 1975, course of the University of Oregon under the guidance of Dr. W. Lamon.

The information contained deals with the Metric Units of Measurement; it provides a detailed study of the concepts of the metric units and how to implement them in the classroom to children.

For this reason this work is primarily intended for the use of teachers, and should not only serve as a guideline to the approach of teaching the metric system but also as a source of reference. The ideas and exercises had been presented and tried in the class and were found extremely useful as a tool for teaching the metric units.

The sequence of the concepts has been carefully arranged and should be followed in the order they are presented with the exception of chapter five which deals with temperature. This chapter can be introduced to the class before the commencement of chapter one or left as it is.

The editors wish to express gratitude to all students for their contribution which made this booklet possible and sincere thanks to Dr. W. Lamon for having provided an inspirational setting for the compilation and integration of the material.

Acknowledgment of the contribution is also given to all publishers who provided information and ideas in many of their pamphlets and publications for the developments of the concepts of the metric units.

G.K.

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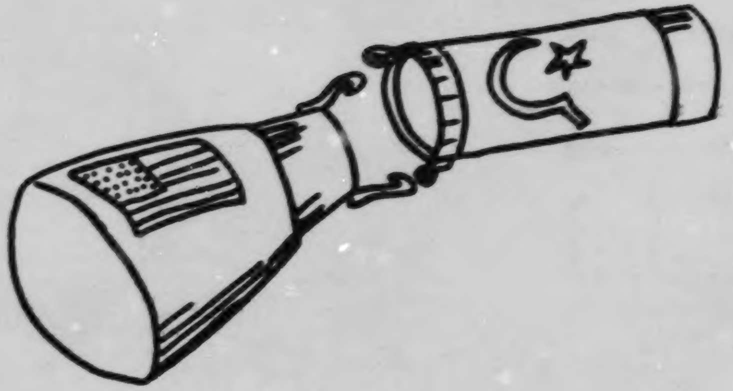
WHY GO METRIC?

HANDBOOK ON THE METRIC SYSTEM OF MEASUREMENT

For the sake of:
COMMUNICATION

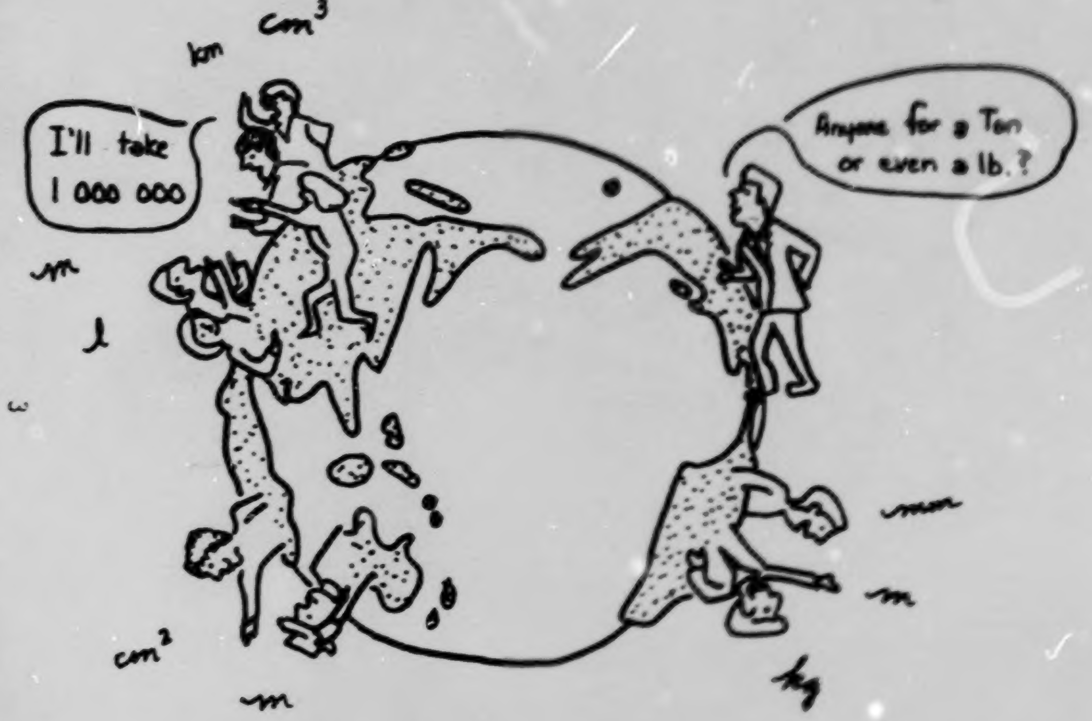
So much has become international.



Sport is international, so is scientific cooperation.

For the sake of:

TRADE

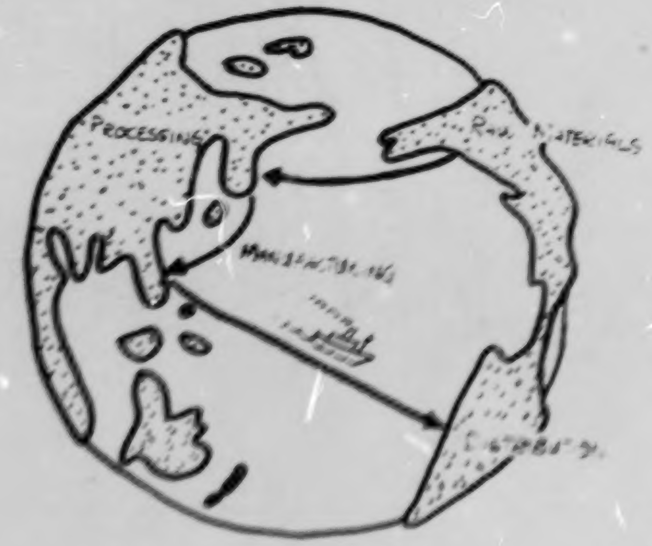

cm³
km
I'll take 1 000 000
Anyone for a Ton or even a lb.?
m
l
mm
m
cm²
m
kg

Major industries need metric to keep abreast of foreign competition. (Some are changing voluntarily)

The Industrialized World -

"the multinational"

The modern approach to manufacturing and distribution needs a unified system of measurements.


PROCESSING
RAW MATERIALS
MANUFACTURING
DISTRIBUTION

For the sake of:

COMPUTATIONAL EFFICIENCY

(with decimals instead of fractions)

Some swimming pool calculations:

	English Units	Metric Units
Length of pool	45 ft, 4 in	13.83 m
Width of pool	25 ft, 6 in	7.78 m
Depth of water	6 ft, 2 in	1.88 m
Flow of water	5-3/4 gal per min	26.13 L per min

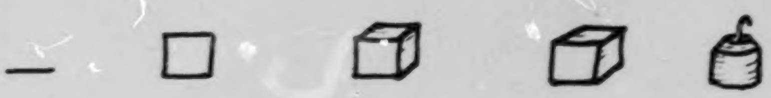
Perimeter	45-1/3+25-1/7+45-1/3+25-1/2(in)	13.83+7.78+13.83+7.78 (m)
Area	45-1/3 x 25-1/2 (sq. ft.)	13.83 x 7.78 (m^2)
Volume	45-1/3 x 25-1/2 x 6-1/6(cu.ft.)	13.83 x 7.78 x 1.88(m^3)
Capacity	Vol in cu ft x cu ft x 6-1/4 (gal)	Vol in m^3 x 1 (kl)
Time in fill	Capacity ÷ 5-3/4 (min)	Capacity ÷ 0.02613 (min)

For the sake of:

COHERENT INTERRELATIONSHIPS

Length: **Area**: **Volume**: **Capacity**: **Mass**
(of water)

$\text{cm} \rightarrow \text{cm}^2 \rightarrow \text{cm}^3 \rightarrow \text{m}\ell \rightarrow \text{g}$



$\text{dm} \rightarrow \text{dm}^2 \rightarrow \text{dm}^3 \rightarrow \ell \rightarrow \text{kg}$

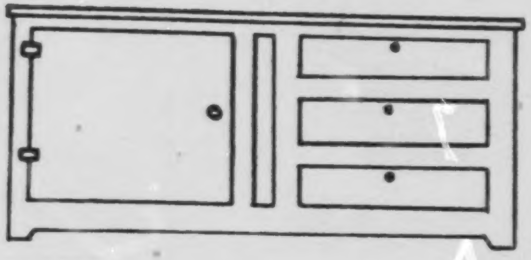
$\text{m} \rightarrow \text{m}^2 \rightarrow \text{m}^3 \rightarrow \text{k}\ell \rightarrow \text{t}$

$$\left.\begin{array}{ll} 10\,\text{m} & 100\,\text{m}^2 \\ 1\,\text{dm} & 1\,\text{dm}^2 \end{array}\right\} 1\,\text{a}$$

$$\left.\begin{array}{ll} 100\,\text{m} & 10\,000\,\text{m}^2 \\ 1\,\text{hm} & 1\,\text{hm}^2 \end{array}\right\} 1\,\text{ha}$$

For the sake of:

EASIER PRECISION DETERMINATION



ENGLISH UNITS:	METRIC UNITS:
A. Width of Door:	
$17\frac{5}{32}$ in $\pm$ $\frac{1}{64}$ in	43.6 cm $\pm$ 0.05 cm
B. Length of Top:	
1 yd, 0 ft, 5 $\frac{7}{32}$ in	1 m, 0 dm, 4 cm, 7 mm or 1.047 m

---

For the sake of:

SIMPLIFYING AND STANDARDIZING SIZE

Toothpaste Containers:

FROM 29 SIZES TO 6

Paper:

FROM 50 STOCK SIZES 12

Nuts and Bolts:

FROM 88 VARIETIES TO 9

Windows:

FROM 1500 STOCK SIZES TO 150

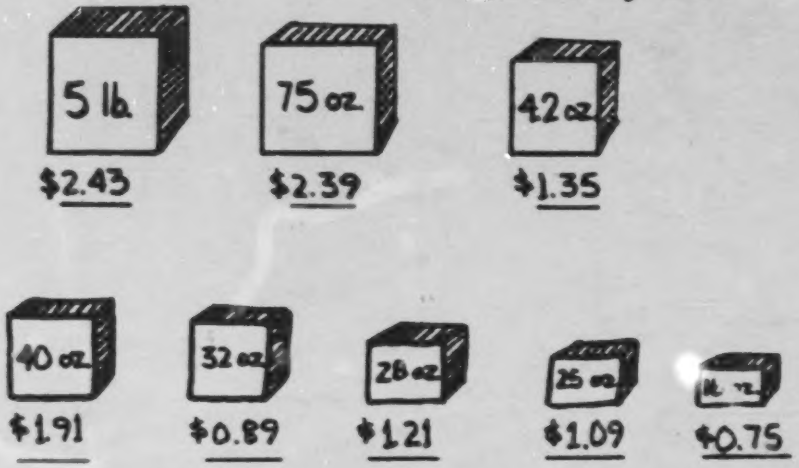
Basic Units:

FROM 53 to 7

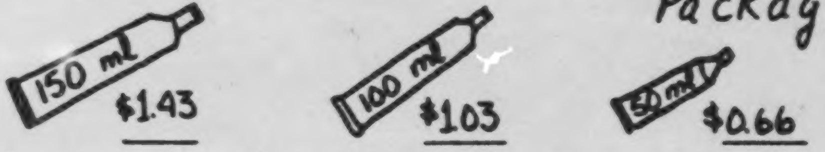
For the sake of:

PRICE COMPARISONS

Soap Prices, (Non-Metric Packaging)


5 lb.
$2.43
75 oz.
$2.39
42 oz
$1.35
40 oz
$1.91
32 oz
$0.89
28 oz
$1.21
25 oz
$1.09
16 oz
$0.75

Toothpaste Prices, (Metric Packaging)

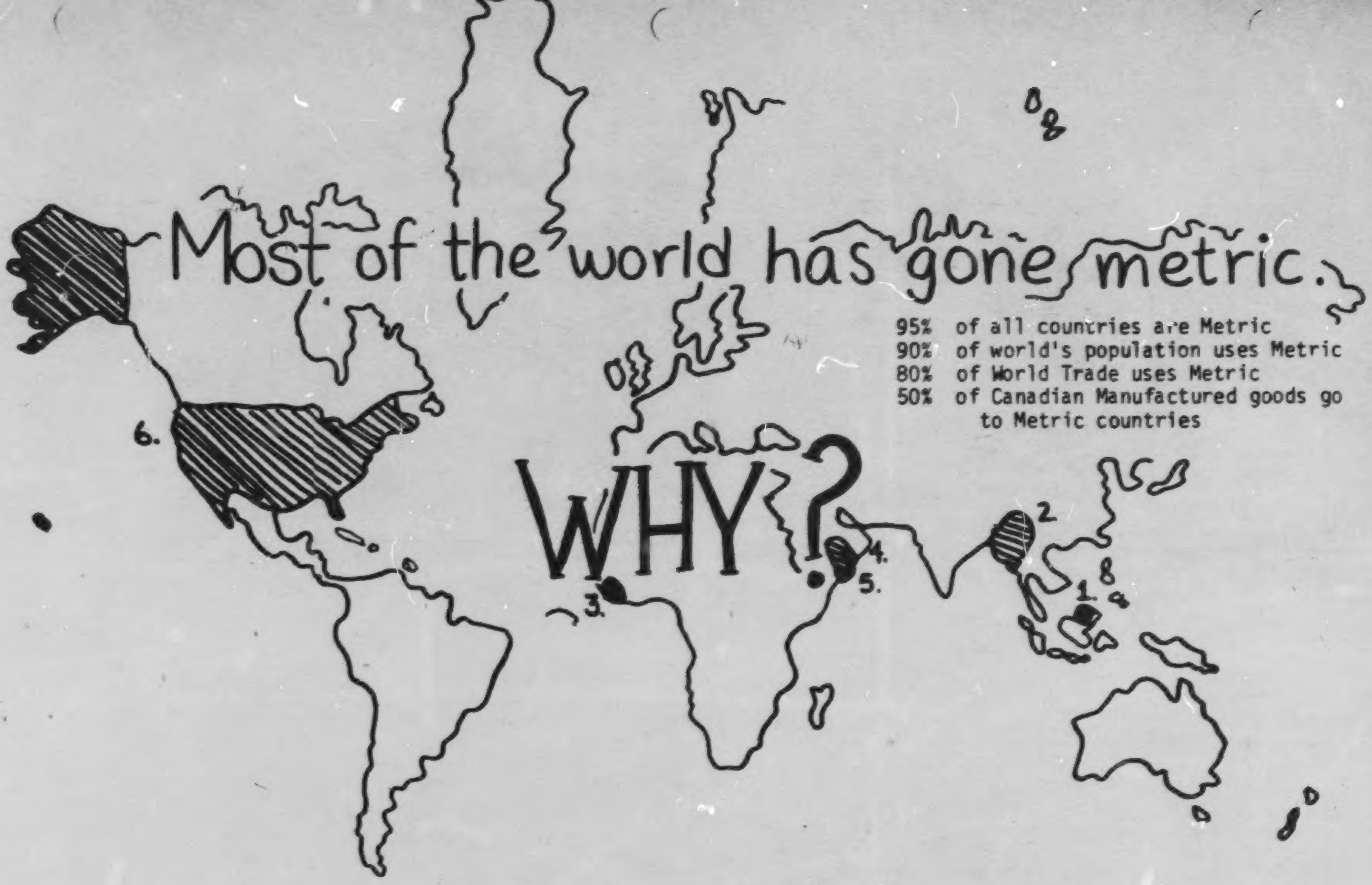

150 ml
$1.43
100 ml
$1.03
50 ml
$0.66

7

Most of the world has gone metric.

95% of all countries are Metric
90% of world's population uses Metric
80% of World Trade uses Metric
50% of Canadian Manufactured goods go to Metric countries

WHY?



● *Islands in a metric world:*

1-Brunei
2-Burma
3-Liberia
4-The Yemen Republic
5-The Yemen People's Democratic Republic
6-The United States of America

History of Metrics

Like it or not - admit it or not, we are in a metric transition period. The metric system is already being used in natural science, work, some segments of industry, medicine, defense, some automotive industry, and in sports contests.

Just when did this "metric measurement" business get started? It all began at the time of the French Revolution when wide variations of measurement existed and the need for some uniform acceptance was dire.

The following list of dates and events give some picture of the history of metrics:

1740 - France adopted the provisional metre (meter) of measurement.

1970 - U.S. President George Washington asked Thomas Jefferson to prepare a plan for a uniform system in weights and measures.

1791 - Twelve members of the French Academy of Science created the Metric System. The French Academy invited the Royal Society of London to join them, but they declined.

1793 - France adopted the provisional kilogram.

1799 - France adopted a standard metre and kilogram.

1821 - John Quincy Adams presented a report to the U.S. Congress advocating the adoption of the metric system.

1840 - France decreed old measures illegal for use and possession was punishable - thus making metric conversion effective.

1866 - The U.S. Congress adopted the metric system as a legal system of measurement.

1866 - England adopted the metric system as a legal system of measurement.

1873 - Canada adopted the metric system as a legal system of measurement.

1875 - An International Bureau of Weights and Measures established the "Treaty of Meter" which was signed by seventeen countries - including the U.S.

1894 - The U.S. War Department adopted the metric system for war medical work.

1902 - The U.S. Health Department adopted the metric system.

1926 - A bill to change to the metric system failed in the U.S. Congress.

1932 - The American Athletic Union adopted the metric system.

1960 - The U.S. National Bureau of Standards issued a chart giving three basic metric units of measure for length, mass, and volume celsius temperature scale.

1960 - Paris Conference adopted the "Systeme International d'Unites" (S.I.).

1968 - The U.S. National Bureau of Standards issued a chart giving six basic metric units of measure, and a metric study act was passed to evaluate the impact of the metric trend in America.

1971 - A report to the U.S. Congress entitled "A Metric America--A Decision Whose Time Has Come" was presented by the National Bureau of Standards. This report was the outcome of intensive study involving nearly all segments of society.

1971 - Canada's Consumer Packaging and Labelling Act required metric values in retail packaging.

1972 - The U.S. National Bureau of Standards issued "The Modernized Metric System" with seven basic units of measurement and two supplementaries.

1973 - Spring issues of "The Arithmetic Teacher" feature metric information, problems, and activities for the use of teachers.

1973 - Two new bimonthly metric journals, "Metric News" and "The American Metric Journal" appeared on the scene with current metric information.

1973 - The American National Metric Council was established.

1974 - On May 7, the U.S. Congress voted against the metric conversion bill.

1974 - The U.S. National Council of Teachers of Mathematics adopted a resolution to urge Congress to pass a bill to implement the metric system by 1983.

1975 - California's public schools will convert to the metric system of measurement in September.

1983 - This is the projected date for the U.S. changeover to the metric system of measurement.

Limerick: written by a first grade teacher after a metric workshop -

There once was a student named Peter

Who asked, "Why use meter and liter?"

But when he found out,

He let out a shout,

"Cause meter and liter are neater!"

WHY GO METRIC IN THE CLASSROOM?

We are an island in a metric sea. Even England, the home of our measurement system is going metric as well as both of our neighbors, Canada and Mexico.

The Metric Conversion Act (HR 11035) will be passed sooner or later. Even without an act of Congress, the U.S. is going metric for international trade reasons.

A metric education resolution has been presented to the Oregon Board of Education by Mr. Jesse Fasold, Superintendent of Public Instruction. The resolution, which has received preliminary approval, calls for all textbooks selected after November 1976 to use metric units as the primary system of measurement. It also calls for complete metrication of all phases of public school operation by 1983.

RECENT ARTICLES on METRICATION (thanks to The Arithmetic Teacher)

"Metrication: not if but how" - N.C.T.M. Metric Implementation Committee, The Arithmetic Teacher. May, 1974, pages 366-69.

The slogan for the National Council of Teachers of Mathematics is THINK METRIC. In this article are offered guidelines for planning a sequence of activities that will put new life into the study of measurement in general, and assure that major ideas are taught and learned. Emphasis is on active involvement using simple relationships, estimation, and a "hands-on" approach, especially at an early age.

Guidelines for teaching the metric system are then given. The main points are:

1) Begin with metric system to avoid conversion.

2) Begin with a basic unit - primary - centimeter
- interm. - meter

3) Omit rarely used prefixes such as deka, hecto, etc.

4) For older children approximate conversions may be helpful such as: 1 kg is a little more than 2 pounds
or
1 km is a little more than ½ mile
but these should be estimations and kept minimal.

5) Use metrics at every opportunity. Parent workshops, metric newsletters would be helpful in presenting metrication to the community.

==

"Metricating - Painlessly, cheaply, cooperatively." Cathy Peavler, The Arith. Teacher. Oct. 74, pages 533-36.

Included here are some suggestions for use in the classroom, for finding materials, and for involving the school and community in a metrication program. "Let everything you do with measurement be done in metric measurement."

For suggestions with regard to innovative ways to metricate cheaply this is a good source if you cannot afford commercial sources for metric measuring aids.

==

"Metrication of the American Family." Donna Lampman. Arith. Teacher, Dec. 1974, pages 707-709.

An all-school assembly organized and produced by a grade 5 class and aimed at presenting the 3 basic concepts of metric measure - meter, liter, and gram in a very simple and concrete manner to primary children. Songs, skits, and interviews with supposed star atheletes like Mark Spitz and Frank Shorter and presented all in metric language. The final curtain is drawn as the chorus sings, "Centimeter Worm" and the audience is urged to "Go Metric."

Newspaper and Short Magazines Articles

NEWSPAPER ARTICLES:

The following articles are from the New York Times

Feb. 3, 1974 76:1 - "Curriculum Services Bur. Dir. Kenneth B. Fetter comments on the Metric System"

Feb 17, 1974 IV 7:4 - "Calculate, centimeters, Millimeters, and Kilometers

March 12, 1974 13:1 - "H.R. Rules Comm. pulled bill off calendar, precluding vote on Metric System"

May 8, 1974 13:1 - "H.R. Rejects 240-153, bill that would gradually covert U.S. to Metric System"

May 12, 1974 IV 20:1 - "Comment on deafeat in U.S. H.R. of proposal that U.S. adopt Metric System of Weights and Measure

* May 21, 1974 40:5 - "William McCullan letter opposes U.S. adoption of the Metric System"

June 8, 1974 30:3 - "Parochial; urges adoption of Metric System"

June 21, 1974 - "Urging adoption of Metric System fails to mention that many professionals use foot as measurement with decimal system"

July, 6 1974 16:4 - "Fredrick T. Gutman - urges adoption of Metric System"

*Aug. 30, 1974 28:1 - "Education hails introduction of Metric system into the Educational System"

Sep 12, 1974 38:5 - "Writer urges N.Y. Times to order all its writers to commence using Metric System in their articles that deal with measurement"

Sep 23, 1974 34:5 - "Daniel Meltz urges and is avocating the adoption of the Metric System into the U.S."

Dec 27, 1974 51:6 - "U.S. Changes to Metric with 7-up Company introducing in '75 six-pack of 7-up in half-liter bottles"

* Summary of this article in booklet

NEWSPAPER ARTICLES:

The following articles are from the New York Times

- * March 9, 1975 III 5:5 - "Thomas Margansen hold cost of U.S. conversion to Metric System to be enormous"
- * March 30, 1975 16:4 - "Canada, on April 1, will begin gradual switch to Metric System."
- * March 30, 1975 IV 11 - "Uncola to become Unounce"

The following articles are from the Portland "Oregonian"

June 7, 1974 1:6 - "Metric Plan use approved (to be taught in public schools exclusively beginning in 1983)

June 29, 1974 15:7-8 - "B.P.A. adopts metric use"

MAGAZINE ARTICLES:

- * U.S. News, March 3, 1974 - 78:54 - "Metric System is creeping in on the U.S."
- * Education Digest January 1975 - 40:54-6 - "Move to Metric System by D.H. Firl"

* Summary of this article in booklet

Newspaper Article Summaries:

Canada: Will gradually Shift to Metric System, Starting Tuesday

The article talks about the U.S. being the only major country left not using the metric system. Canada, has already been using the celsius scale thermometer in their radio and television forecast. Canada, doesn't want people converting but to reorient their thinking. They have sent out pamphlets such as "Weather Goes Metric." The snowfall and rainfall will measured in centimeters. They plan to be fully metric by 1980.

The Uncola is about to be Unounced

The 7-up Company is planning to replace their pint and quart bottles to half-liter and liter bottles, over the next ten years. That started this process this last spring. Also the Christian Borothers winery of Napa, California will start bottling their table wines in 375 milliliters bottles. Most all companies are trying to start the change over to metric by January 1, 1979. The foul lines in the RIVERFRONT Stadium in Pittsburg has 100.58 meters marks.

Letters to Editors: Of Liters of Sense

This writer said, that the metric system had a short coming when you are working in daily type situation. You have a problem he says, "A liter of milk is too small and a kilo of butter is more than what you need." The person writing is also an architect and worked with the metric system in Europe. He feels that there is no convenient division between the meter and the centimeter, with the American system, the foot, you can divide into 1/3, 1/2, 1/4, and etc., and three feet equals a yard. His final comment was, "Why change something that has been here five thousand years."

Magazine Article Summaries:

Move to Metrics - Some Considerations by Donald H. Firl

There are problems with the metric system. One, there needs to be one basic metric system, because countries are writing their words different, and some have different meanings (they have a committee working on this problem.) When people are using this metric system, they need to think only of that system, and no other system.

The Metric System is Creeping in on the United States

General Motors is changing their engines to 2.3 liters. Thirty to forty percent of Ford productions is in foreign markets where the metric system is standard, and they are using it. Fabric will be measured in centimeters and meters. The new standard size for the widely used office paper is 210 by 280 millimeters. There are 14 states that are in the early stages of preparing classes in metric system. Six states have enacted laws calling for the metric system to be taught. There are some states that are trying out kilometers by putting them on mileage signs. They have an American National Metric Council to help businesses and Government in the change over. One problem is that businesses need to change over from standard tools to metric tools, and they want the Government to pay for it. The Government has indicated that they won't pay for everything, but there is a Bill that will grant up to $2,000.00 to help offset the tool replacement costs.

CHAPTER ONE

THE METRIC MEASURE OF LENGTH

INTRODUCTION

"Chapter One" deals with the metric units of length and as such it is the most important chapter of this booklet. All the other metric concepts develop from the basic unit of length which is the "METER".

The meter can be multiplied by the values of ten to obtain larger units, the decameter, the hectometer and the kilometer, or it can be divided by the values of ten to form smaller units of measure, the decimeter, the centimeter and the millimeter.

The meter, kilometer and the centimeter are more frequently used than the decimeter, decameter and hectometer. The importance of the decameter and the hectometer lies in the measurement of area. The decameter if squared will form the "are", and the hectometer, if squared, will give us a "hectare", which is made out of one hundred ares, or 10,000 square meters.

This chapter contains games, exercises and activities for all age-groups. "How many Shoes", "Measure with a Wheel", "Secret Measure", and "The World's Largest Ant" are activities primarily designed for the younger children, while "Shirt Pattern Centimeters", "Metric-English Comparison Graph", "Hands-on Workshop", "Longer Distances", "Use a Ruler", "Personal Record", "Measure of Pacing", and "Floor Plans" are activities more appropriate for the upper elementary grades. They can also be used for adult teaching of the metric system and in the secondary grades.

LENGTH AND MEASURING

Length can be determined using a ruler or tape measure. Size implies how long? how high? how wide? Distance implies, how far or how near to a given point from another. Metric Length units include meters (m), decimeters (dm), centimeters (cm), the very small millimeters (mm) and other large units. All are related to each other by the factor 10.

Young children should be encouraged to start measuring with non-standard measuring units like their hands and feet. When they are ready to be introduced to measuring, start with the meter and work down to the centimeter. The millimeter should be introduced at an older grade.

For the first introductory lesson, I would recommend that you use the Metric Linear Measurement Set (Creative Publications $13.95). Start with the white unmarked meter stick and measure some item that needs precise measurement down to the centimeter. Work the students to the point of discovering that they need small units for preciseness and that these units need names. Then introduce the color coded metric sticks. An excellent activity that would help many students now would be to make their own metric sticks. They then should measure objects of importance to them in their community like themselves, personal possessions, and home. These sticks may also be used to teach money, place value and decimals because all of these are based on 10.

Some extra ideas are: determining circumference by using string or yarn; measuring shadows; measuring plants (their growth); have the students do some guessing before they measure items.

General Objectives:

1. Provide physical experience with measurement in arbitrary units. (I-1 uses shoes; I-2 uses wheels.)

2. Encourage the students to think about advantages or disadvantages of different measurement techniques and to verbalize their ideas. (Accept any reasonably articulated answers to the opinion questions; the purpose is to encourage analysis as a habit.)

3. Lead the students to discover the inverse relationship between size of measuring unit and number of units obtained as a measure. I-1 does this simply on a more or less basis; in I-2 the two wheels which the student constructs have a 2:1 relation. The student may notice this. He deserves some congratulations if so, -- but it is not an important point to stress.

4. Lead to discussion of advantages of standardization of measurement units.

5. Give the student experience in following written directions. (Possibly the most important single skill your students can develop is the ability to learn from reading.)

6. Provide experience in constructing and using a measurement tool. Have the student make trundle wheels. As far as the sheet is concerned, the "wheel" is treated as an arbitrary unit. It is actually a carefully chosen metric measurement, however, Wheel #1, which the student is asked to save, is a half-meter (50 cm) in circumference, so the student can use it later as a measuring tool in other activities, where he needs to measure out distances.

Comments:

I-2 is discussed on this page as well as I-1 because the teacher side of I-2 is devoted to a pattern and instructions for making a 1-meter trundle wheel for general use. If you do not already have a trundle wheel, you will find this very simple to make, at essentially no cost for materials.

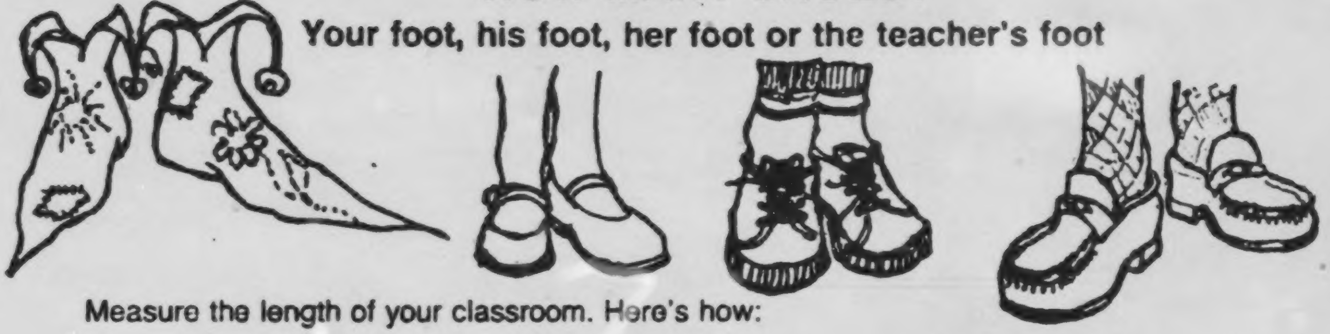
Further Activities:

Many other arbitrary units can be used for length activities: hands, pencils, crayons, belts, lengths of yarn -- the possibilities are limited only by what you feel you would like to use and how much experience your students have already had with such topics.

When it comes to area and volume, later, you can also start with arbitrary units to provide a rationale for the standard metric units. Example: How much is a "glass"? Students can bring examples of many different glasses, with a very wide variance in volume.

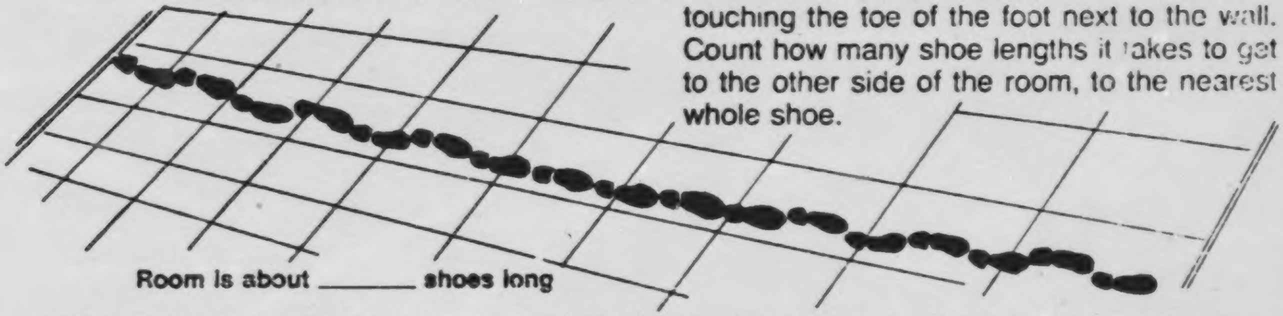
HOW MANY SHOES?

Your foot, his foot, her foot or the teacher's foot



Measure the length of your classroom. Here's how:

1. Start with the heel of one foot at the side wall. Put the heel of the other shoe directly in front, touching the toe of the foot next to the wall. Count how many shoe lengths it takes to get to the other side of the room, to the nearest whole shoe.



Room is about ______ shoes long

2. Choose 2 other students in the room whose feet are not the same size as your feet. Have them count how many shoes the same way you did.

Name of person I chose	How many shoes?	Feet bigger or smaller than mine?
______	______	______
______	______	______
______	______	______

Why might the 3 people get different numbers for the length of the room? ______

______

If the tallest teacher in the school measured the length the same way, do you think his count would be the same as yours, a larger number of shoes, or a smaller number of shoes? ______

______

What do you think is good or bad about this way of measuring lengths? ______

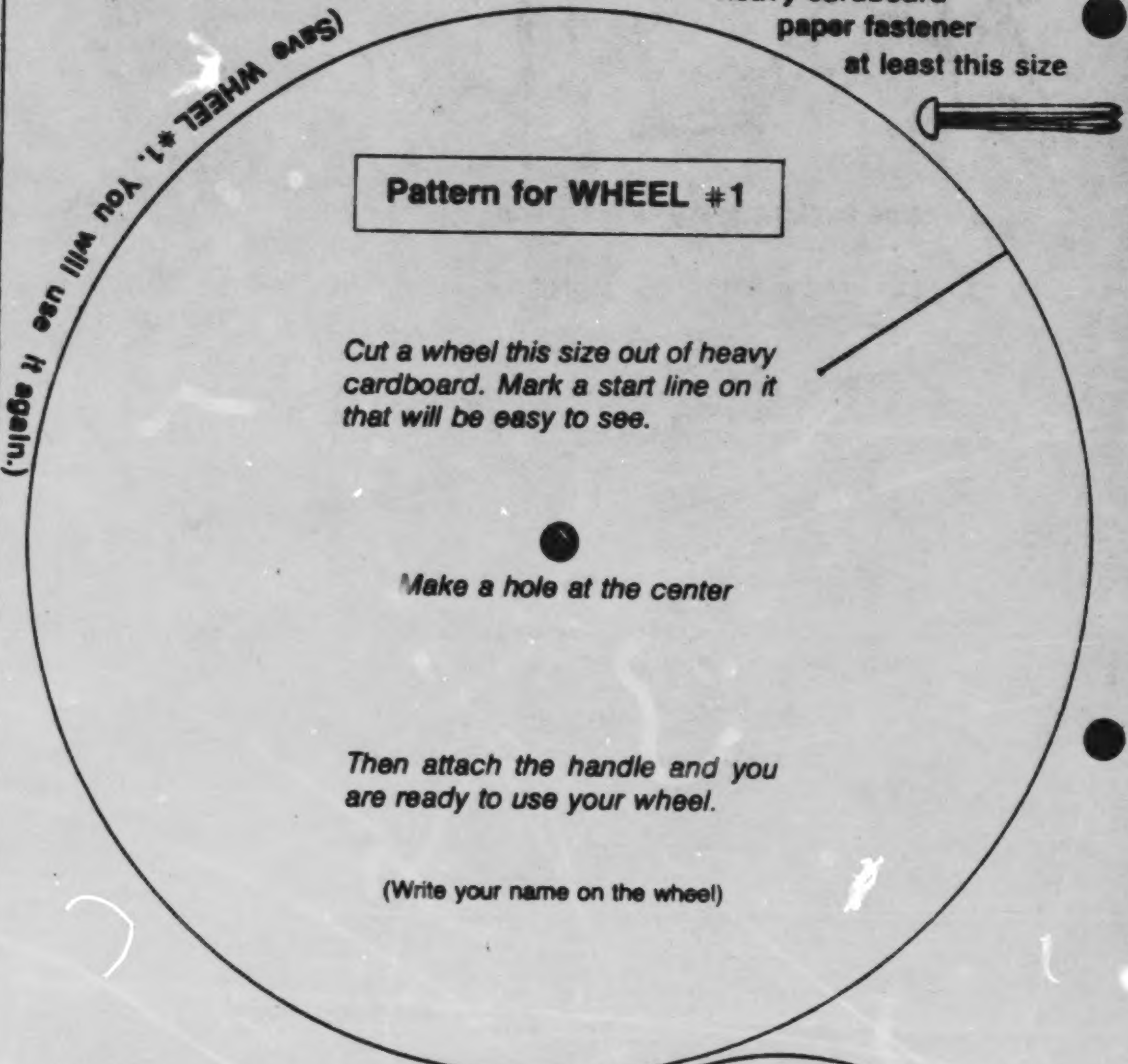
______

______

Make a hole

MEASURE WITH A WHEEL

To make your measuring wheels, you need: **scissors**
heavy cardboard
paper fastener
at least this size



(Save WHEEL #1. You will use it again.)

Pattern for WHEEL #1

Cut a wheel this size out of heavy cardboard. Mark a start line on it that will be easy to see.

Make a hole at the center

Then attach the handle and you are ready to use your wheel.

(Write your name on the wheel)

Pattern for a Handle

Cut a piece of strong stiff card-board this size or longer.

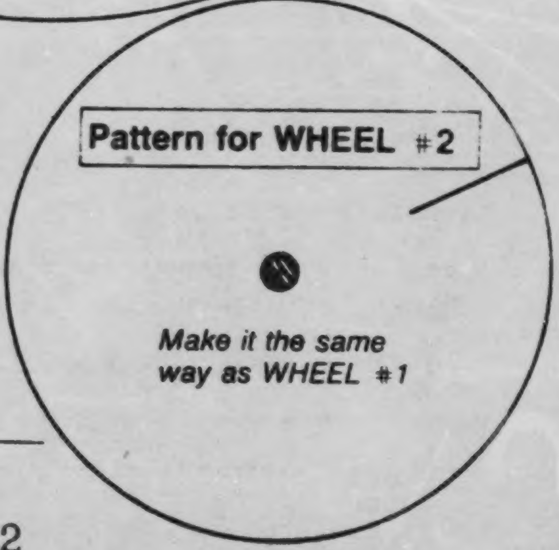
(A stick will work even better, if you can get one with a hole in it.)

When you finish making your wheels, measure how long the blackboard is.

Attach the handle to wheel #1 and count how many full turns it takes to roll it the length of the blackboard.

Closest to _______ full turns.
Now try it with wheel #2.

Closest to _______ turns.
Are your answers the same? _____
Why? _________



Pattern for WHEEL #2

Make it the same way as WHEEL #1

SHIRT PATTERN CENTIMETERS

The students use a tape to take measurements.

General Objective:

The student gains further practice and familiarity with centimeters and half-centimeters, regularly using the decimal notation of .5 for half (after whatever numeral was in the one's place).

The students work in pairs to take the following measurements:

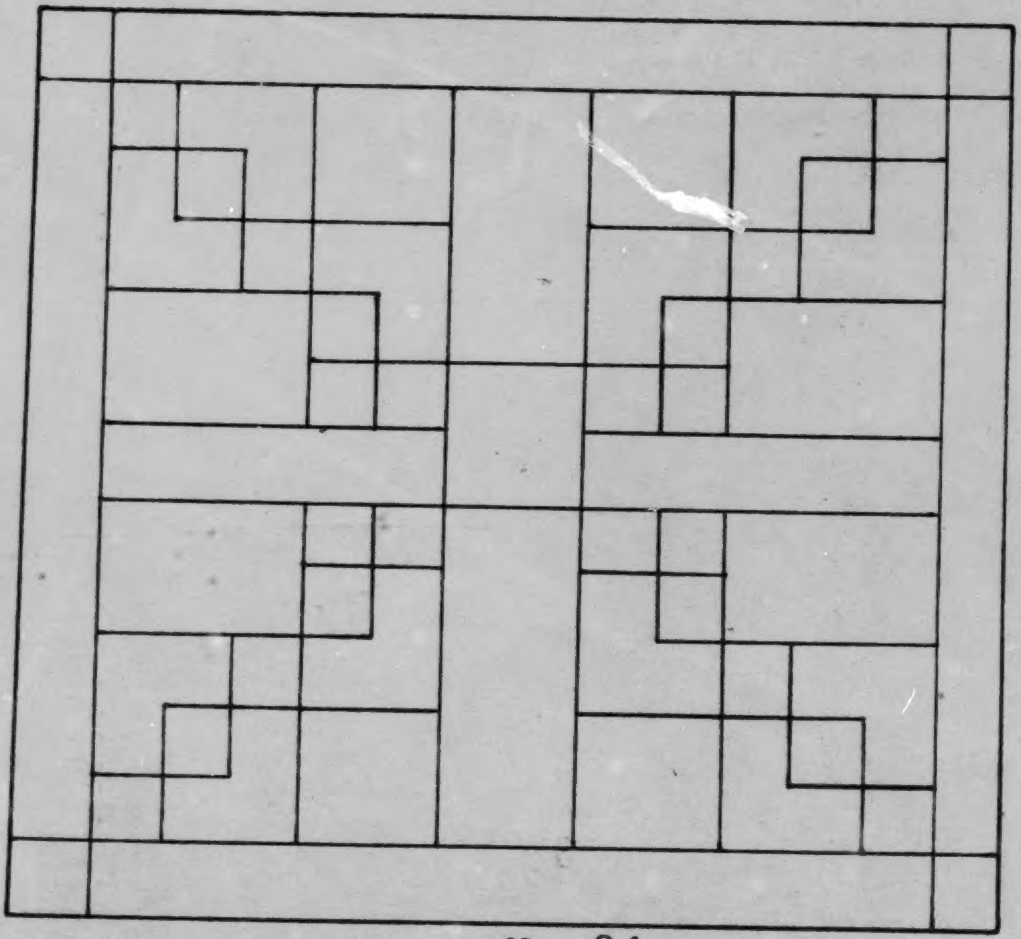
1. neck
2. sleeve
3. chest
4. nape of neck to waist

Using these measurements, draw the patterns on newspapers. (Allow a few cm for seam.)

Cut out and staple together.

COLOR CENTIMETER UNIT

1. Color all 1 cm x 1 cm black
2. Color all 2 cm x 2 cm yellow
3. Color all 1 cm x 11 cm blue
4. Color all 1 cm x 12 cm green
5. Color all 2 cm x 5 cm purple
6. Color all 2 cm x 3 cm orange
7. Color all 1 cm x 5 cm brown
8. Color all 2 cm x 4 cm pink



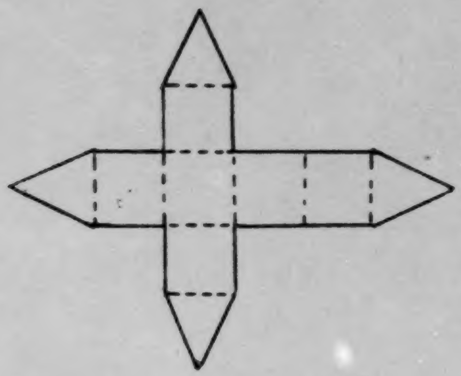
MOBILE CUBES

The students can see the relationship between types of metric measurement - length, volume and weight by making two special cubes:

1 cm^3 or 1 cm x 1 cm x 1 cm = 1 ml = 1 g.

1 dm^3 or 10 cm x 10 cm x 10 cm = 1 L = 1 kg.

Pattern for 1 cm^3 Fold on dotted lines.



35

USE A RULER

This length is 1 cm

This length is ______ cm

This length is halfway between 1 cm and ______ cm

(Use your ruler to see)

We can cut a centimeter into ten pieces

Then each piece is 1 tenth of a centimeter = 0.1 cm

Half of a centimeter is the same as ____ tenths = 0.5 cm

How long is this segment? ______ cm

Draw a segment 4.5 cm long:

Draw a segment 6.5 cm long:

Draw a square 1 cm on each side:

Draw a square 2 cm on each side

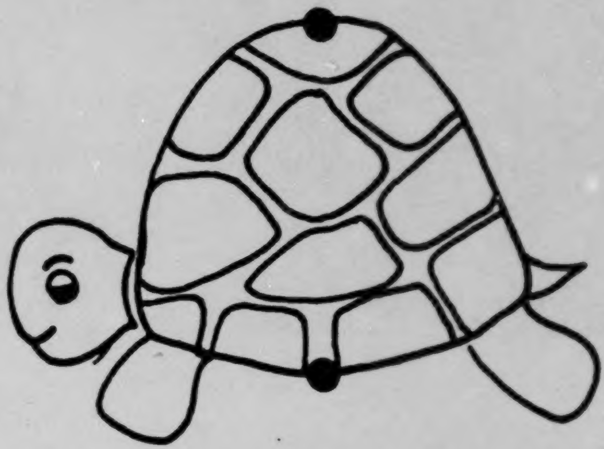
How many of these squares, 1 cm on each side, would fit in the bigger square you drew, 2 cm each way? ______

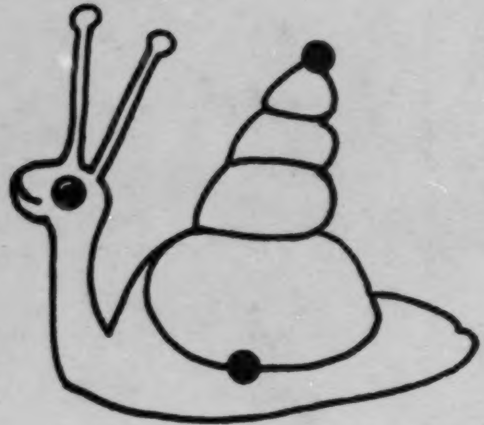
Try to guess (estimate) some lengths. Then measure them and see how close your guess was.

	Guessed about	Measured about
1. Length of your pencil	______ cm	______ cm
2. Length of your middle finger	______	______
3. Length of ______	______	______
4. Length of a new piece of chalk	______	______
5. Length of a chalkboard eraser	______	______
6. Width of the chalkboard eraser	______	______
7. Length of this lab sheet	______	______
8. Width of this lab sheet	______	______
9. Length of your shoe	______	______
10. Width of your shoe, across the widest part	______	______

STUDENT ACTIVITY

RULER OF ANIMALS

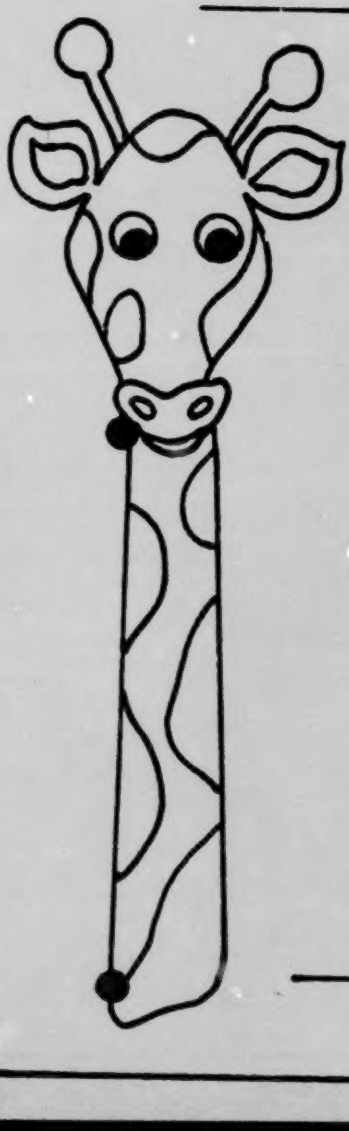


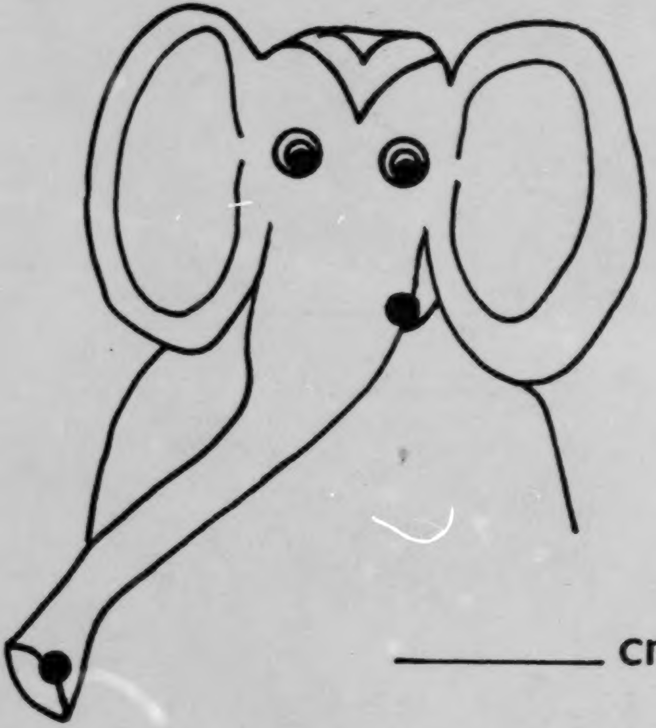


Whose shell is taller?

______ cm

______ cm





______ cm

A shorter neck or trunk?

______ cm

DESIGN A CENTIMETER PICTURE

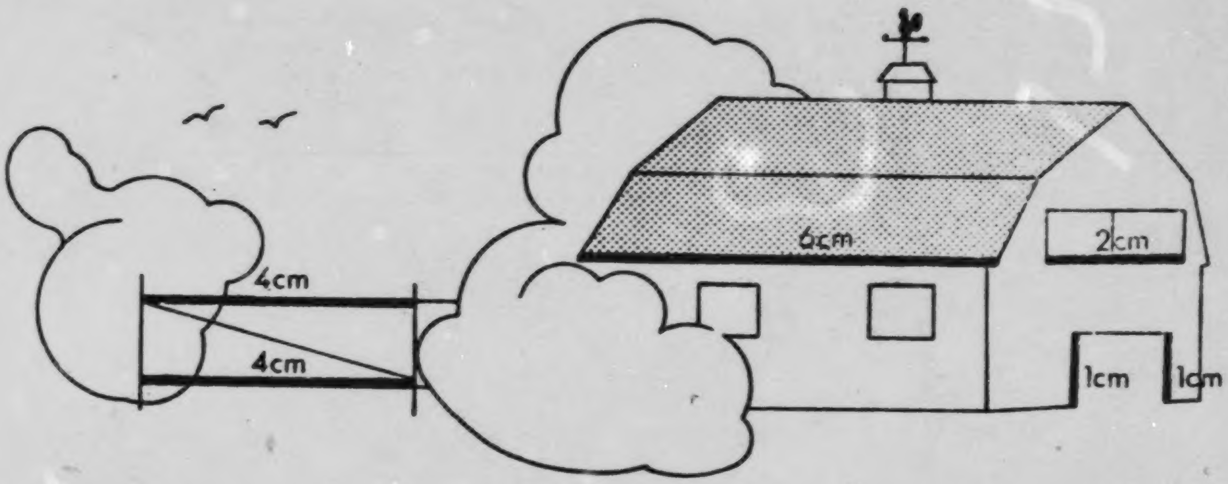
MATERIALS:

Spin-top, page 10
centimeter ruler
pencil
paper
crayons

Letting the numerals on the spin-top represent the number of centimeters, spin the top 6 times. Record the number of centimetres the top indicates after each spin.

e.g., 4cm, 1cm, 2cm, 1cm, 4cm, 6cm

Draw a picture using the lengths you recorded ---



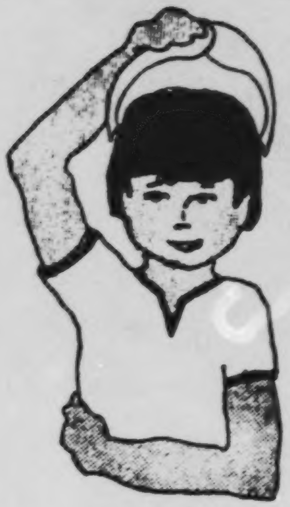
VARIATION:

After each spin, draw the lengths on a blank piece of paper.
Design a picture using these 6 random lengths.

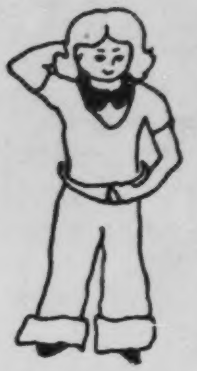
STUDENT ACTIVITY

CALIPER ACTIVITIES

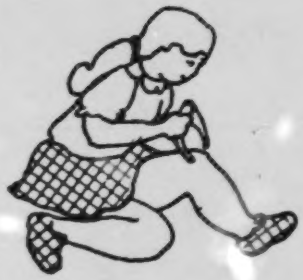
Use calipers to determine distance across the widest part of:



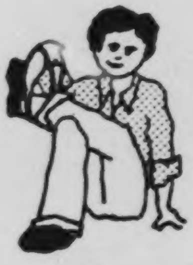
My head ______________________ cm



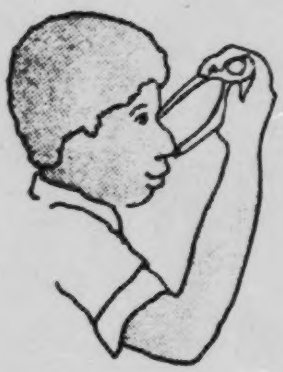
My waist ______________________ cm



My knee ______________________ cm



My ankle ______________________ cm



My nose ______________________ cm

PERSONAL RECORD -- How Big?

This sheet gives the student a record page, with two columns, illustrated to show the measurements he is to make. For some of the activities he is asked to work with a friend.

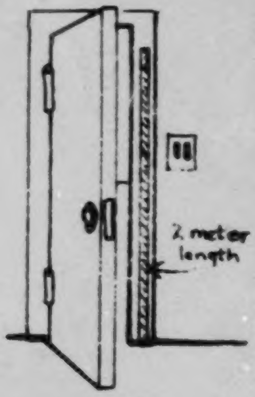
General Objectives:

1. Student develops increasing familiarity with measurement in meters and centimeters, in the context of his own measurements.

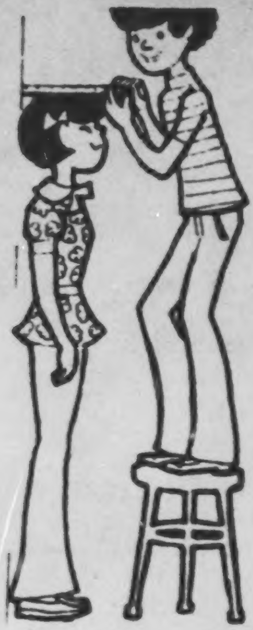
Comments:

Everyone is most interested in things that affect him directly (at any age)! This applies with particular force to the young students. You can add further measurements to the record list if you wish: around calf of leg, for example. Or you can have the students measure typical lengths necessary for fitting clothes, nape of neck to waist, trouser lengths, etc. (In such a project, it would be advisable to have the students use the regulation metric tape measure provided in the kit rather than the self-made tapes.)

Use the pressure-sensitive mylar tape provided in the kit to provide an easy vertical "height chart" in a convenient place like a door frame. (A 2 meter length next to a door will provide an excellent immediate visual reference available for the students at all times. Since the tape is marked in centimeters, with millimeter divisions, students will see the further subdivision of units as well. At the end of each meter on the roll of sticky tape, there is a box where you can indicate how many meters, so the students realize that the second hundred centimeters actually represents 1 meter plus the indicated number of centimeters.) Also set up some permanent horizontal 1-meter lengths of tape for visual reference and students' use in measuring objects easily. A square, 1-meter on each side, on a bulletin board will be useful later, in area discussions.



The height chart will probably motivate student interest in millimeters for future work, even though they are presently asked to measure only to the closest centimeter or half-centimeter.

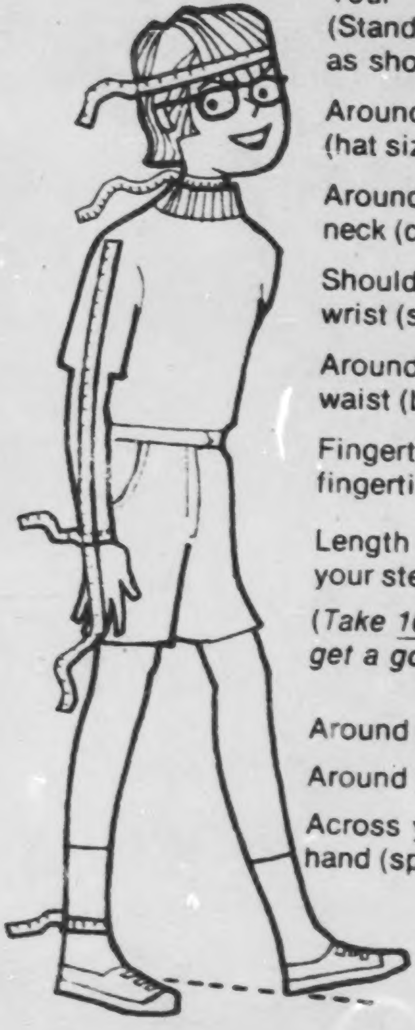


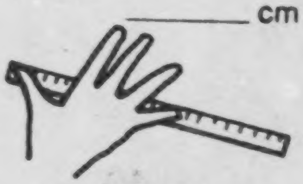
PERSONAL RECORD —How big?

Work with a friend to help you measure and fill out the chart. (It's hard to measure your own height!) Save the record, to see how much you grow in a year.

Name: ______________________

First date measured: ____________		Next Date:
Age: _____ years + _____ months		Age: ____
Measure		
Your height _______ cm (= _____ m) (Stand up straight against a wall as shown in the picture at top)		______
Around your head (hat size)	_______ cm	______
Around your neck (collar size)	_______ cm	______
Shoulder to wrist (sleeve length)		
Around your waist (belt size)	_______ cm	______
Fingertip-to-fingertip (reach)	_______ cm	______
Length of your step	(10 paces = about _____ m	______
	= ______ cm)	______
(*Take 10 steps to get a good measure*)	1 pace = about _____ cm	______
Around your wrist	_______ cm	______
Around your ankle	_______ cm	______
Across your stretched hand (span)	_______ cm	______





METRIC-ENGLISH COMPARISON GRAPH

Let kids measure their favorite objects in the classroom in both English and metric units. Make a comparison graph (see attached sheet) to visually represent the objects in both systems of measurement.

1. Possible problems
   a. Be sure they are aware that the difference in heights of the bars are because of different units of measurement. They may assume that the taller bar is a greater distance, volumn, thickness, etc.
   b. There are two units of measurement on the graph. Be sure not to assign either value to the lines or spaces of the graph.
2. Alternative
   a. Make the exercise a homework assignment. They might be more interested in measuring things they have at home.

SCALE MODELS

1. It might be a good idea to have taught the concept of scale drawings before you get to your metric unit. If, you have kids who have already mastered metric usage, you could have them build metric scale models to correspond to other subject areas.

   Examples: 1) Indian villages made to scale
   2) Model railroad lay-out
   3) Slot-car lay-out
   4) Western Army fort

MAKING ARBITRARY UNITS OF MEASUREMENT

1. After they have used the wheels in I-1, give groups of students a choice of implements to make units of measurement. Have each group make several measurements with their units. After they have been made, let the groups try and figure out which units all the other groups made.

METRIC GUESSING GAME

Object of the game: To gain as many points as possible for your team.

Players: Three players (or a few more) on each team. One measurer score keeper.

How to make points: The scorer holds up an object of which teams #1 and #2 will make a measurement guess. First they must draw a card from a unit deck. The unit deck is a deck of cards marked mm, cm, dm, m, etc.

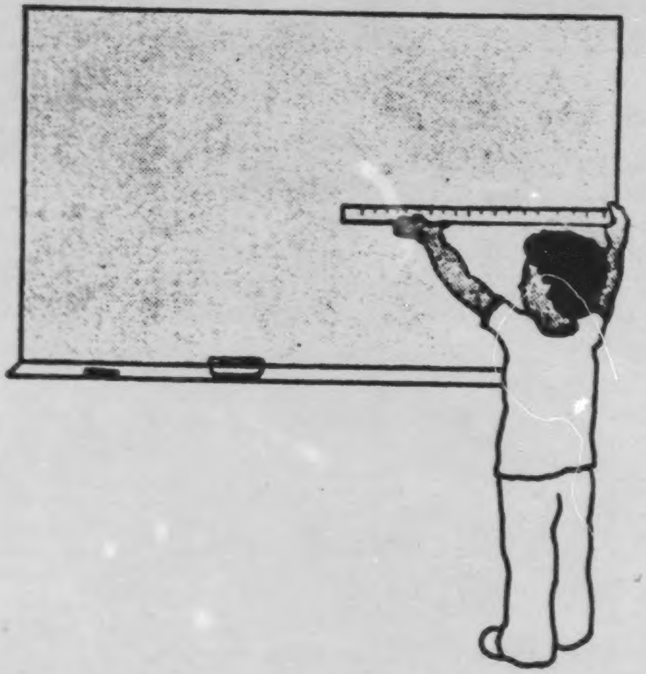
* You should have several cards for each unit. If they draw a card marked mm they will have to make their guess to the nearest millimeter. If they draw a card that says meter they will have to make their guess to the nearest meter and so on. The team that guesses the closest gets the point for that round. The number of rounds can be arbitrarily chosen. The team with the most points at the end of all the rounds is the winner.

* It is a good idea to put only metric abbreviations on the cards. This requires them to become familiar with the use of metric abbreviations.

STUDENT ACTIVITY

SECRET MEASURE

Measure and record, in centimeters, the length of an object in the room that can be seen easily. Tell the other students the length of your secret object. Allow them 10 guesses to guess what your secret object is.



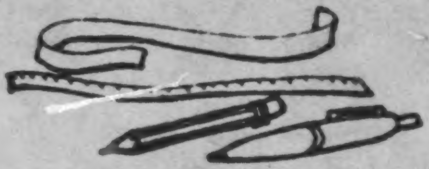
My SECRET OBJECT is ____________________

The length of my secret object is ___________cm.

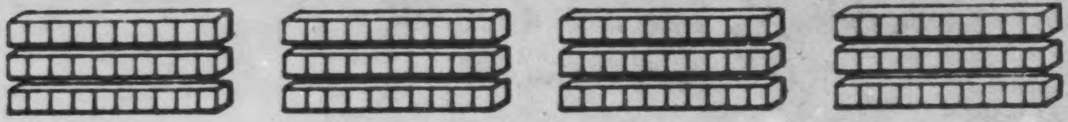
44

MAKE A METRIC TAPE

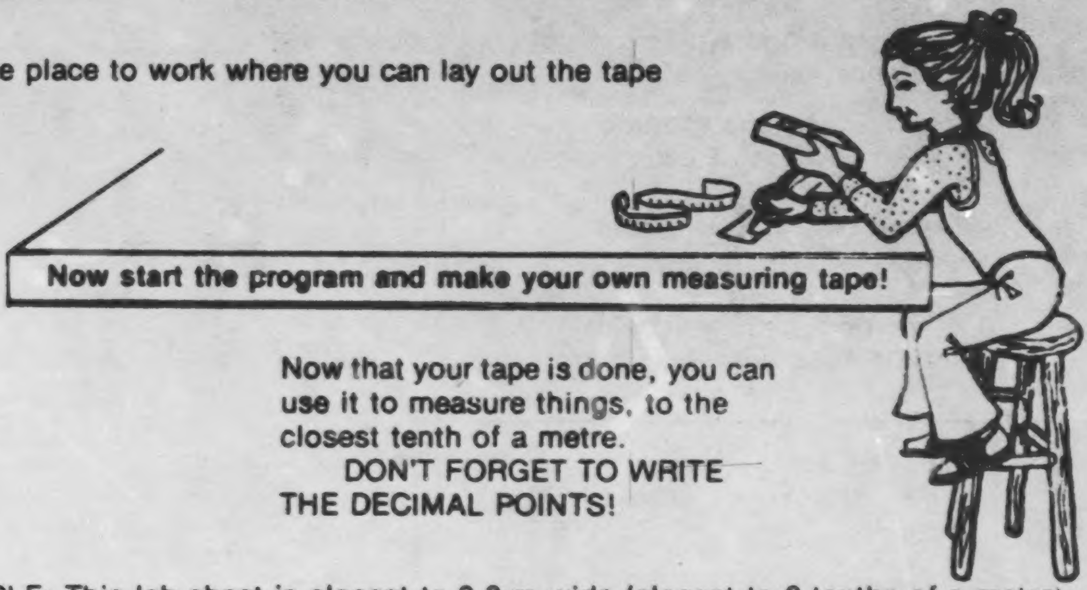
You need the Telor program on how to make your own measuring tape and:



1. a blank tape from the kit
2. a marked meter tape
3. a pencil and a ball-point pen
4. 12 of the 10 cm rods



5. some place to work where you can lay out the tape



Now start the program and make your own measuring tape!

Now that your tape is done, you can use it to measure things, to the closest tenth of a metre.

DON'T FORGET TO WRITE THE DECIMAL POINTS!

EXAMPLE: This lab sheet is closest to 0.2 m wide (closest to 2 tenths of a meter)

Measure from the floor to the bottom of the doorknob in your room. It is about ________m high.

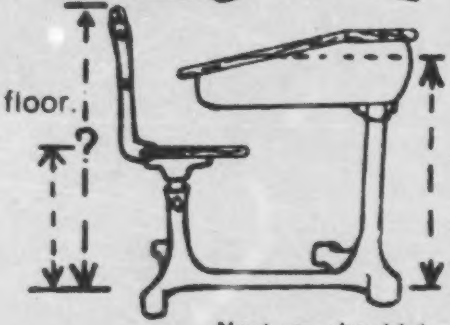
The door is about ________m wide.

The top of your desk is about ________m high.

The seat of your chair is about ________m high.

The top of your chairback is about ________m from the floor.

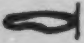
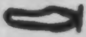
Measure a friend. From the floor to your friend's shoulder is about ________m.



Next you should do Lab Sheet L-2

MEASURE BY PACING

When you walk, each step you take is about the same length. You can use that fact to measure distances by counting how many steps ("paces") you walk:
Here's how Jack measured the length of his room:
FIRST he needed to know how long his pace was:

1. He marked a starting point.  front of front foot
2. Then he walked 10 paces (steps) and marked the ending spot.  front of front foot
3. Next he measured how far he walked, to the closest tenth of a meter. 5.2 m
4. He tried it over again, and got about the same distance, 5.3 m
5. He used the chart to find about how long 1 pace was:

If 10 paces is: (to the closest meter)	1 pace is about
4 m	0.4 m
5 m	0.5 m
6 m	0.6 m
7 m	0.7 m

About how long is 1 pace for Jack? __________

6. Then he paced the length of the classroom. It was 13 paces.

Jack figured:

10	**paces**	=	**about**	**5.2 m**
+ 1				**0.5 m**
+ 1				**0.5 m**
+ 1				**0.5 m**
13	**paces**	=	**about**	___ . m

7. When Jack measured the room with a tape measure, he got about 6.9 m.
8. How close was his answer by pacing to his measured length?

Think: 6.9
− 6.7 ______ m

You can try measuring your pace and your classroom the same way.

10 paces: about ________
From the chart:
1 pace is about ________

Classroom is ________ paces.
Can you figure how long the room is?
10 paces = about ________ m

?
?
?
?
?
?

____

FLOOR PLANS: More about scale drawing

A "floor plan" of a room (or a house) is a scale drawing. First you'll use a floor plan. Later you can make your own floor plan.

You need:

Ruler, pencil and paper.
The floor plan says what scale is used. it is ________ .

Notice:

That means that 1 cm on the drawing stands for ________ . In the picture the hall measures 1.5 cm wide. Then the hall must be 1.5 ________ wide.

Do: Use the scale drawing to find lengths in the real house:

Garage (it's a 2-car garage) ____________ m by ____________ m

How wide is the front garage door opening? ____________ m

How wide is the house (side-to-side)? ____________ m

Which is the largest room? ____________________

How long is the central hall? (front-to-back) ____________ m

How big is the living room? ____________ m by ____________ m

How big is the kitchen? ____________ m by ____________ m

How long is the master bedroom? ____________ m

How big is the utility room? ____________ m by ____________ m

How big is the patio? ____________ m by ____________ m

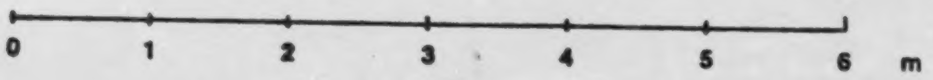
How long is the closet in the master bedroom? ____________ m

How big is a bathroom? (they are both the same size) ____________ m by ____________ m

Do: Choose any room you want. Then make a drawing using a scale of 1:50 (1 cm on your drawing will stand for 0.5 m; 2 cm on your drawing will stand for 1 m).

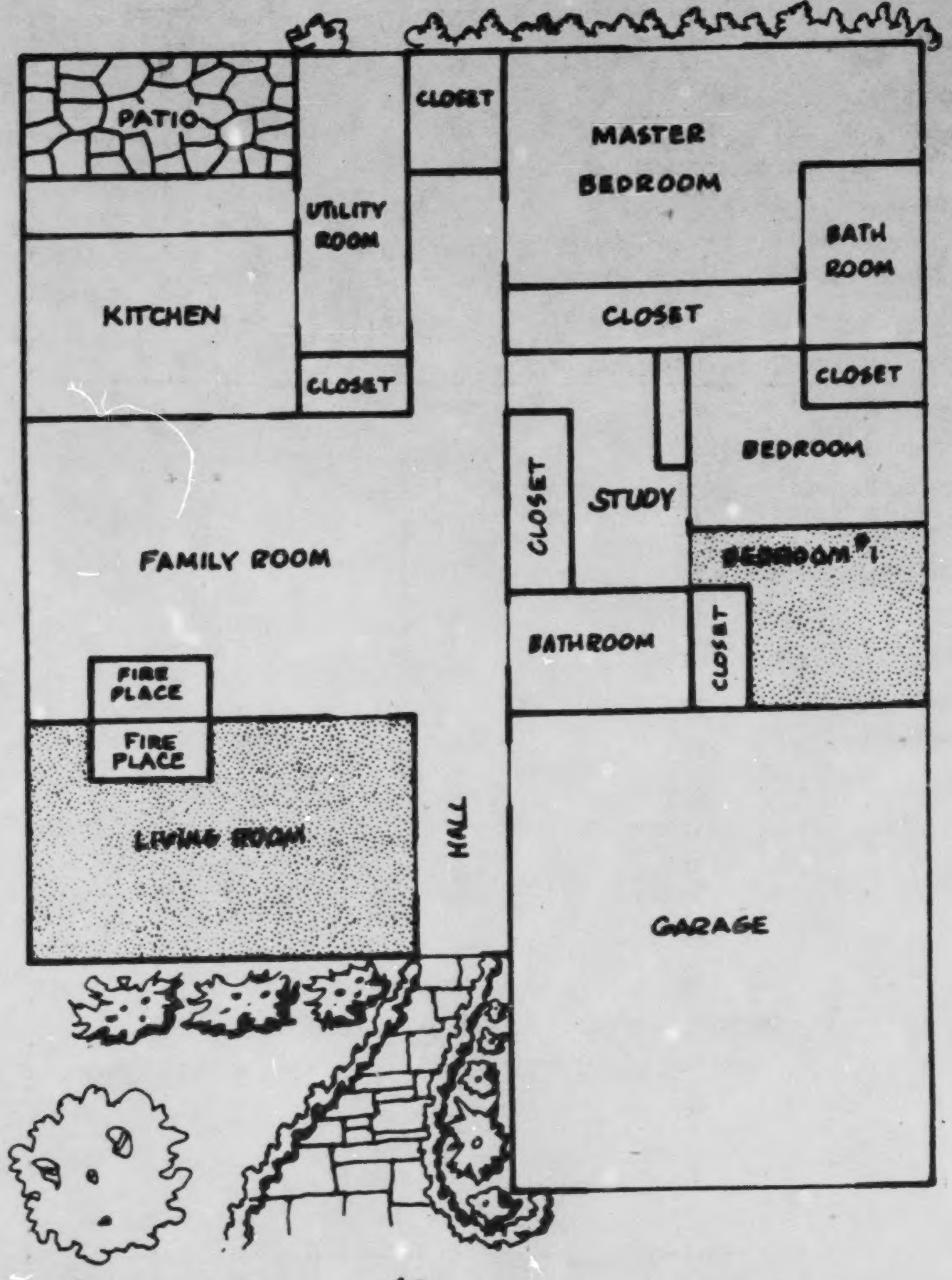
When a draftsman draws a plan, he often uses a "scale ruler" to make it easier. Here's a 1:50 scale ruler you can use:

Scale 1:50



FLOOR PLAN

Scale: 1:100 1cm represents 1m.


PATIO
CLOSET
MASTER BEDROOM
UTILITY ROOM
BATH ROOM
KITCHEN
CLOSET
CLOSET
CLOSET
BEDROOM
CLOSET
STUDY
BEDROOM #1
FAMILY ROOM
BATHROOM
CLOSET
FIRE PLACE
FIRE PLACE
LIVING ROOM
HALL
GARAGE

USE A RULER

The student use a ruler to measure segments and to draw segments and squares.

General Objectives:

1. The students gain further practice and familiarity with centimeters and half-centimeters, regularly using the decimal notation of .5 for half (after whatever numeral was in the one's place).

2. Students start to develop the necessary physical skills involved in using a ruler to draw lengths.

3. Students continue to practice skills in estimating lengths, then measuring them.

Comments:

This sheet represents a sample of a type that will give students valuable practice and experience. Similar assignments can be given readily, and additional practice in using the rulers carefully would be advisable. Probably lengths in whole centimeters or halves should be the only kind the students are asked to draw at this stage.

Additional drawing practice could well include having students use rulers to mark rectangles they are given into centimeter lengths, both in length and width dimensions, then draw segments to separate the regions into centimeter squares. This will be valuable practice for the coming concept of area. (They could color individual squares.)

It would also be appropriate to encourage some idea of subtraction in measurements by more development of holding a ruler next to a segment so it starts at the 1 or 2 or 3 instead of 0, and see how that applies to length.

Comparing the two kinds of rulers in the kit is also a good idea at this point. The lab sheet illustrates cutting a centimeter into ten parts and calls the division 0.1 cm. Sticking to the 0.1 cm notation for the time being would be advisable; it helps reinforce the idea of tenths. The millimeter will be introduced later. If the student asks about it, however, because he looks at the other ruler, you can comment on it. The student is much more attentive to answers to his questions than to general statements!

An additional activity might be to have each student make his own ruler out of tagboard or cardboard, marking it carefully in centimeters and half-centimeters. He could then keep it in his metric folder.

THE MILLIMETER (mm)

- Some ready references

- 10 mm = 1 cm
- thickness of a dime
- diameter of wire in a paper clip
- thickness of 10 sheets of this paper

Measuring in meters to 3 places of decimal

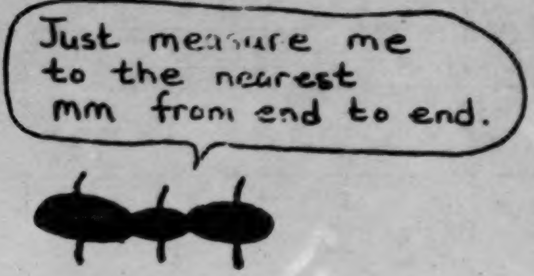
The width of this page is 0 m, 2 dm, 1 cm, 6 mm or, the width of this page is 0.216 m

To acquaint the children with the size of a millimeter give them a task in which they estimate the dimensions of objects in millimeters. After estimating, have them actually measure the objects in millimeters and compare the two answers.

The millimeter (mm) may be used to express dimensions of thumb tacks, paper clips, stamps, films, lenses, matches, buttons, ball bearings, drills, nails, hinges, screws, nuts and bolts, sizes of renches, chisels and screwdrivers, thickness of glass, plywood, and sheet metal, allowances for seams, widths of ribbons and tape, sizes of paper, lumber and shoes, and amounts of rainfall.

WORLD'S LARGEST ANT

Do you realize how big I can get?


Just measure me to the nearest mm from end to end.

Ant = ____ mm

In each box below, draw the line segment to the nearest mm

Ⓐ 3 mm

Ⓑ 7mm

Ⓒ 9mm

Ⓓ 15 mm

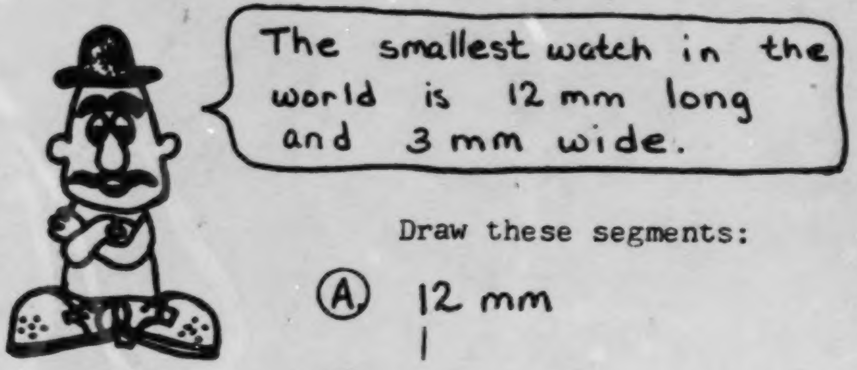
Ⓔ 18 mm

Ⓕ 20mm

Ⓖ 26mm

Ⓗ 52mm

Ⓘ 71 mm


The smallest watch in the world is 12 mm long and 3 mm wide.

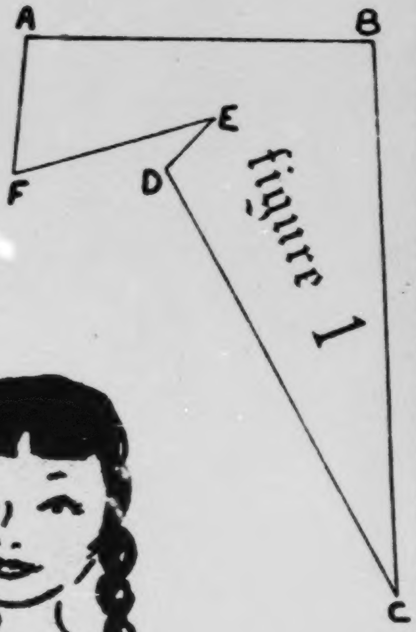
Draw these segments:

Ⓐ 12 mm

Ⓑ 3 mm

OBJECT	ESTIMATE	MEASUREMENT (mm)
1.		
2.		
3.		
4.		
5.		

On figure 1 below, measure each of the line segments to the nearest mm. Then change it to cm.



Segment AB = 50 mm or 5 cm

Segment BC = ____ mm or ____ cm

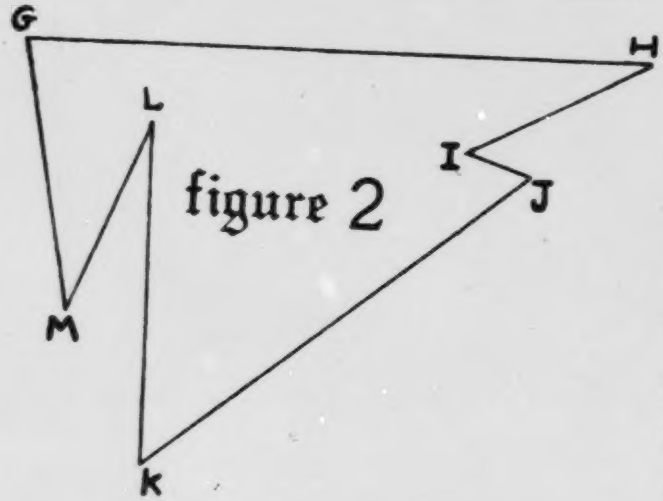
Segment CD = ____ mm or ____ cm

Segment DE = ____ mm or ____ ____

Segment EF = ____ __ or ____ cm

Segment FA = ____ __ or ____ ____

On figure 2, measure each line segment to the nearest cm. Then change it to mm.



Segment GH = 9 cm = 90 mm

Segment HI = ____ cm = ____ mm

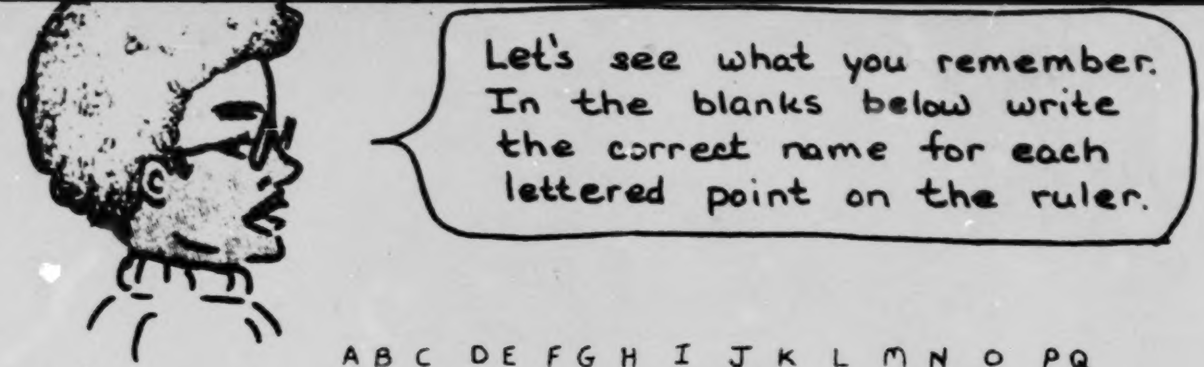
Segment IJ = ____ cm = ____ mm

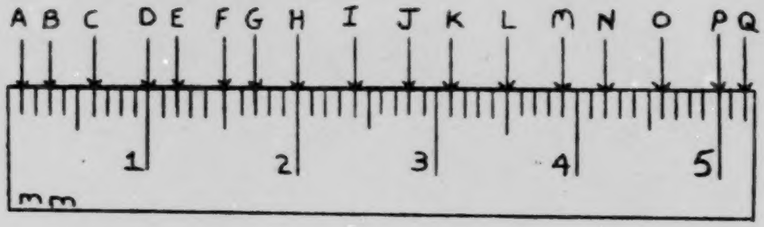
Segment JK = ____ cm = ____ ____

Segment KL = ____ __ = ____ mm

Segment LM = ____ __ = ____ ____

Segment MG = ____ __ = ____ ____


Let's see what you remember. In the blanks below write the correct name for each lettered point on the ruler.


A B C D E F G H I J K L M N O P Q
1 2 3 4 5
mm

A → ______ mm

B → 3 mm

C → ______ mm

D → ______ mm or ______ cm

E → ______ mm

F → ______ mm

G → ______ ___

H → ______ ___ or ______ cm

I → ______ ___

J → ______ mm

K → ______ ___

L → ______ ___

M → ______ ___

N → ______ ___

O → ______ ___

P → ______ ___ or ______ ___

Q → ______ ___

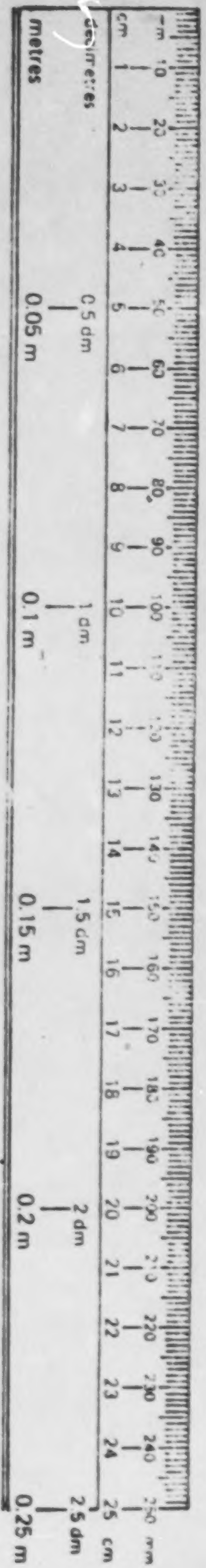
Get the Answer Key for Part 2.

Activities are from: Metric Measurement
Mathematics Basic Skills
Development Project

METRIC MEASURES:

Length in m, dm, cm and mm

After you fill out this sheet, save it for your notes. It will help you remember and use the facts you learn.

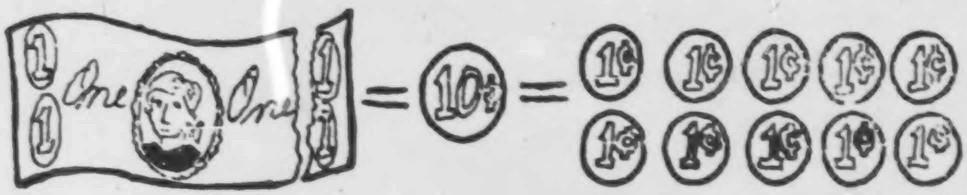

mm
cm
decimetres
metres
0.5 dm
0.05 m
1 dm
0.1 m
1.5 dm
0.15 m
2 dm
0.2 m
2.5 dm
0.25 m
25 cm
250 mm

The right side of this sheet gives you a ruler. The ruler is marked in 4 different units, to show how millimeters (mm), centimeters (cm), decimeters (dm) and meters (m) are related.

To see how the units are related, just look at the ruler, where lengths are named in the different ways.

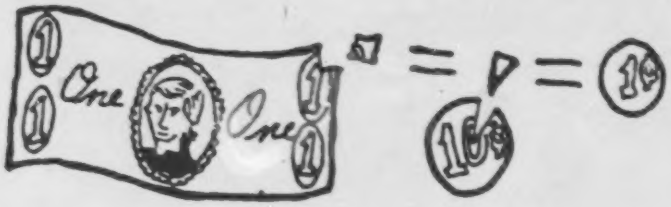
1 tenth of a meter = 0.1 m = 1 dm = 10 cm = _______ mm

(1 tenth of a dollar = 1 dime = _______ ¢)


One
One
1
10¢
1¢

1 hundredth of a meter = 0.01 dm = 1 dm = 1 cm = _______ mm

(1 hundredth of a _______ = $0.01 = 0.1 dime = 1 _______)


One
One
1
10¢
1¢

If you cut a centimeter in 10 parts, each part is called a millimeter.

0.1 cm = 1 _______

Look at the ruler. It is quarter of a meter long.

That is the same as 0.25 ____ = 2.5 ____ = _______ cm = _______ mm.

(You can use the markings on the ruler to help you fill in the blanks.)

0.15 m = _______ dm = _______ cm= _______ mm

9.5 cm = _______ mm

_______ cm = 120 mm

_______ m = 2.3 dm = _______ cm = _______ mm

LINEAR MEASUREMENT - Longer Distances

the decameter (dam)

the hectometer (hm)

the kilometer (km)

Some Ready Referants

the decameter

10 m = 1 dam = width of average classroom

1 dam^2 = 1 are = .25 acre 10 dam = 1 hectometer

the hectometer

100 m = 1 hm = approximate length of football field

1 hm^2 = 1 hectare (ha) = 2.5 acres = 10,000 m^2

the kilometer

1,000 m = 1 km = .6 mile = about 7 city blocks

The decameter and hectometer are not commonly used units of measurement. The meter is usually used instead. They are, however, used for land measurement in determining ares and hectares which are the metric units used instead of the acre and section. For this reason it is important to introduce these terms to your students.

The kilometer is commonly used, and with conversion to the metric system will be used instead of the mile to measure distance. It will be essential on maps, on road signs, in measuring lengths of rivers, national boundaries and distances in space (to planets).

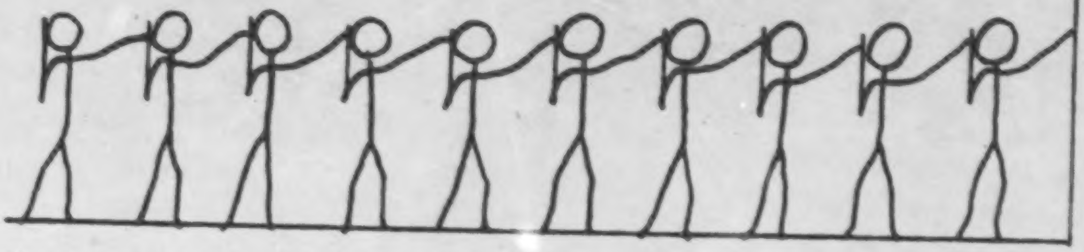
STUDENT ACTIVITIES FOR DECAMETER AND HECTOMETER

* for intermediate level students

1\.

The "Metric Salute" exercise

1. With 10-12 students using the "metric salute", demonstrate 1 decameter.



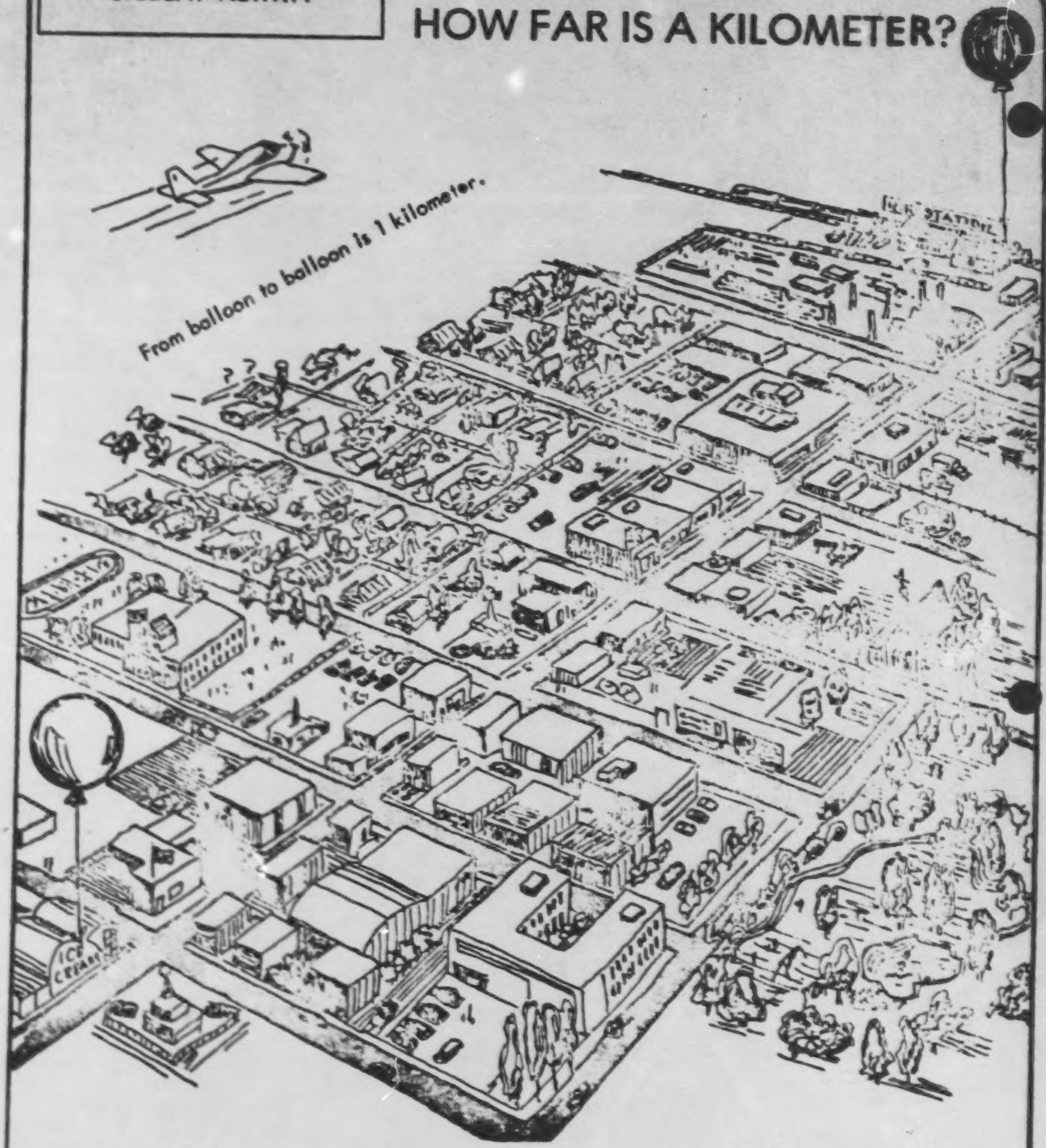
2. Check precision by measuring with a tape, meter stick, or meter wheel.

2. Perimeter is a linear measurement. Measure the perimeter of your classroom in meters. Convert to decameters thus furthering the students' understanding of the relationship between meters and decameters. Have the students first guess how many decameters in the perimeter of the room.

3. To demonstrate the size of an are or 1 dam^2 take the students out to the school-yard and measure off 10 m^2 and explain the usefulness of this unit in land measurement. Also take the students to the football or soccer field and measure the length of 100 meters or 1 hectometer and point out that 1 square hectometer = 2.5 acres = 1 hectare.

STUDENT ACTIVITY

HOW FAR IS A KILOMETER?


From balloon to balloon is 1 kilometer.
STATION
ICE CREAM

Count the city blocks in this kilometer. How many meters long would each block be along the main street? About how long would it take you to walk one kilometer?

How many kilometers would you enjoy on your roller skates before you got tired? How many would you like to travel on a bicycle trip? On a Sunday picnic trip?

STUDENT ACTIVITY

U.S. CITY DISTANCES

Determine and record the distances between the following cities:

Los Angeles to Denver ________km

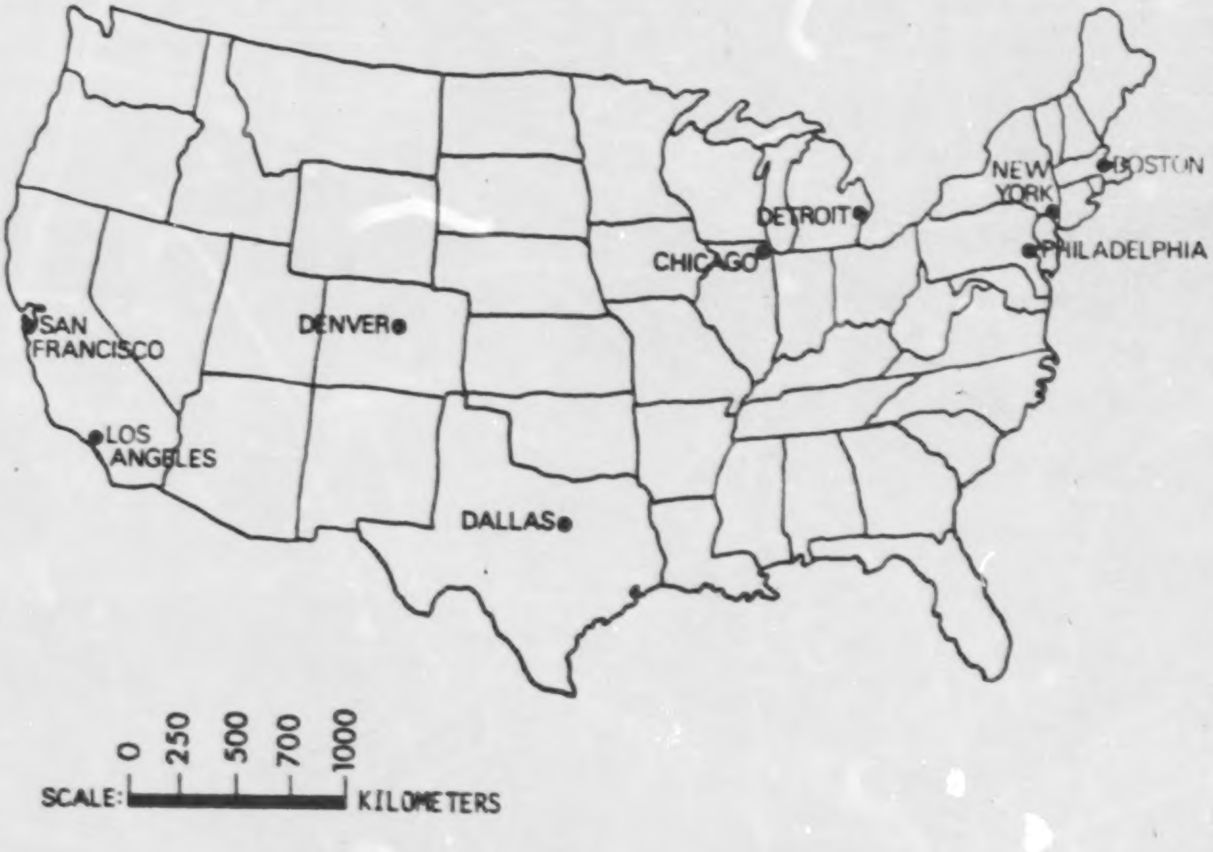
Chicago to Detroit ________km

Dallas to Philadelphia ________km

Boston to Chicago ________km

Los Angeles to New York ________km

Note: Kilometer is pronounced with the accent on the first syllable.


BOSTON
NEW YORK
PHILADELPHIA
DETROIT
CHICAGO
DENVER
SAN FRANCISCO
LOS ANGELES
DALLAS
SCALE:
0
250
500
700
1000
KILOMETERS

Exercise - The "Road map" exercise

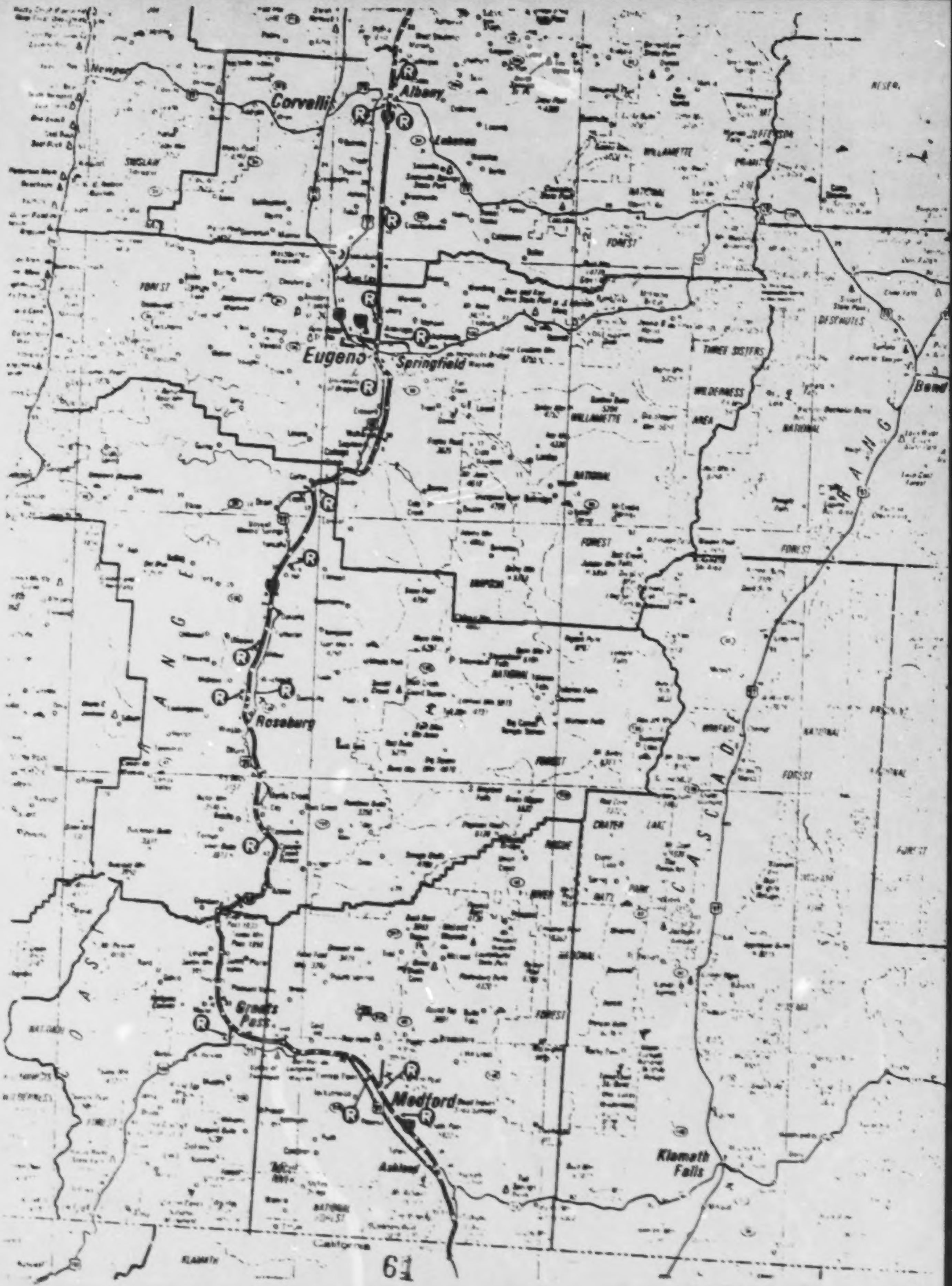
Using the yellow road map determine

1. The distance from the center of to the center of
2. The distance from to , "as the crow flies."
3. Complete this kilometer chart:

From, To					
	●				
		●			
			●		
				●	
					●

The kilometer (km) of course will be essential on maps, on highway road signs; in long distance running and driving events; in measuring lengths of rivers, national boundaries, and distances to the planets. Odometers will be designed to indicate kilometers and speed limits will be expressed in kilometers per hour.

The decameter is rarely encountered in real life. The hectometer will generally be expressed in terms of 100 m as in the 100-meter dash. A knowledge of this unit is useful in visualizing an area of one hectare which equals a square hectometer.


Newport
Corvallis
Albany
Lebanon
SIUSLAW
WILLAMETTE
NATIONAL
FOREST
JEFFERSON
RESER.
Eugene
Springfield
THREE SISTERS
WILDERNESS
AREA
DESCHUTES
NATIONAL
Bend
RANGE
WILLAMETTE
NATIONAL
FOREST
UMPQUA
NATIONAL
Roseburg
FOREST
CASCADE
FOREST
CRATER LAKE
NAT'L PARK
ROGUE
RIVER
NATIONAL
FOREST
COAST
Grants Pass
Medford
Ashland
Klamath Falls
NATIONAL
FOREST
KLAMATH
California

CONSTRUCTION PROJECT

SPINNING TOP FOR METRIC GAMES

TO CONSTRUCT THE SPINNING TOP:

1) Cut next page.

2) Pressing hard, score along all dotted lines with a blunt stylus or the corner edge of a nickel. Then cut out carefully and fold as indicated.

3) Hold all 6 points together evenly and wrap them with a narrow strip of adhesive tape, to bind them together.

4) Pierce a hole through the marked center of the base.

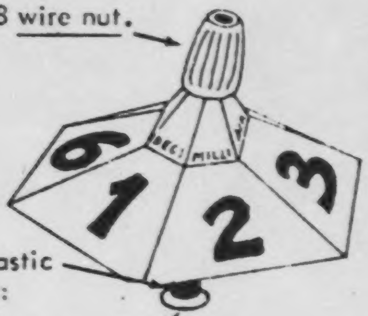
5) Slip the plastic tube spacer onto the split fastener. *

6) Push the split fastener with spacer in place, up through the pierced center hole all the way into the cluster of wrapped points.

7) Turn (twist) the wire nut tightly onto and over the points so it engages the tip of the split fastener through the wrapped points.

Hardware item:

No. 10-18 wire nut.

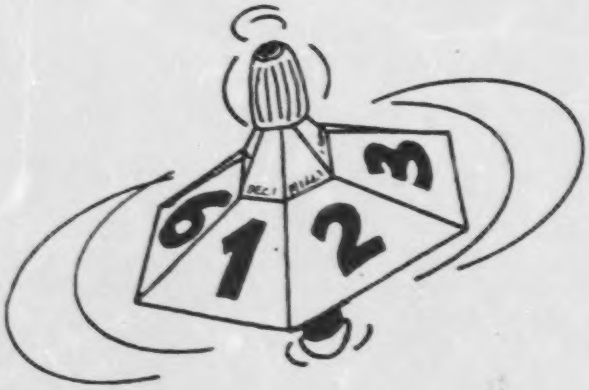


Stationery items:

1) 1/4" plastic tube spacer: cut a piece about 24 mm long.

2) Round head split fastener: do not bend.

*If plastic tubing spacers are not available, wrap a quantity of adhesive tape or masking tape several times around the shank of the split fastener, covering about 22 mm next to the fastener's head.



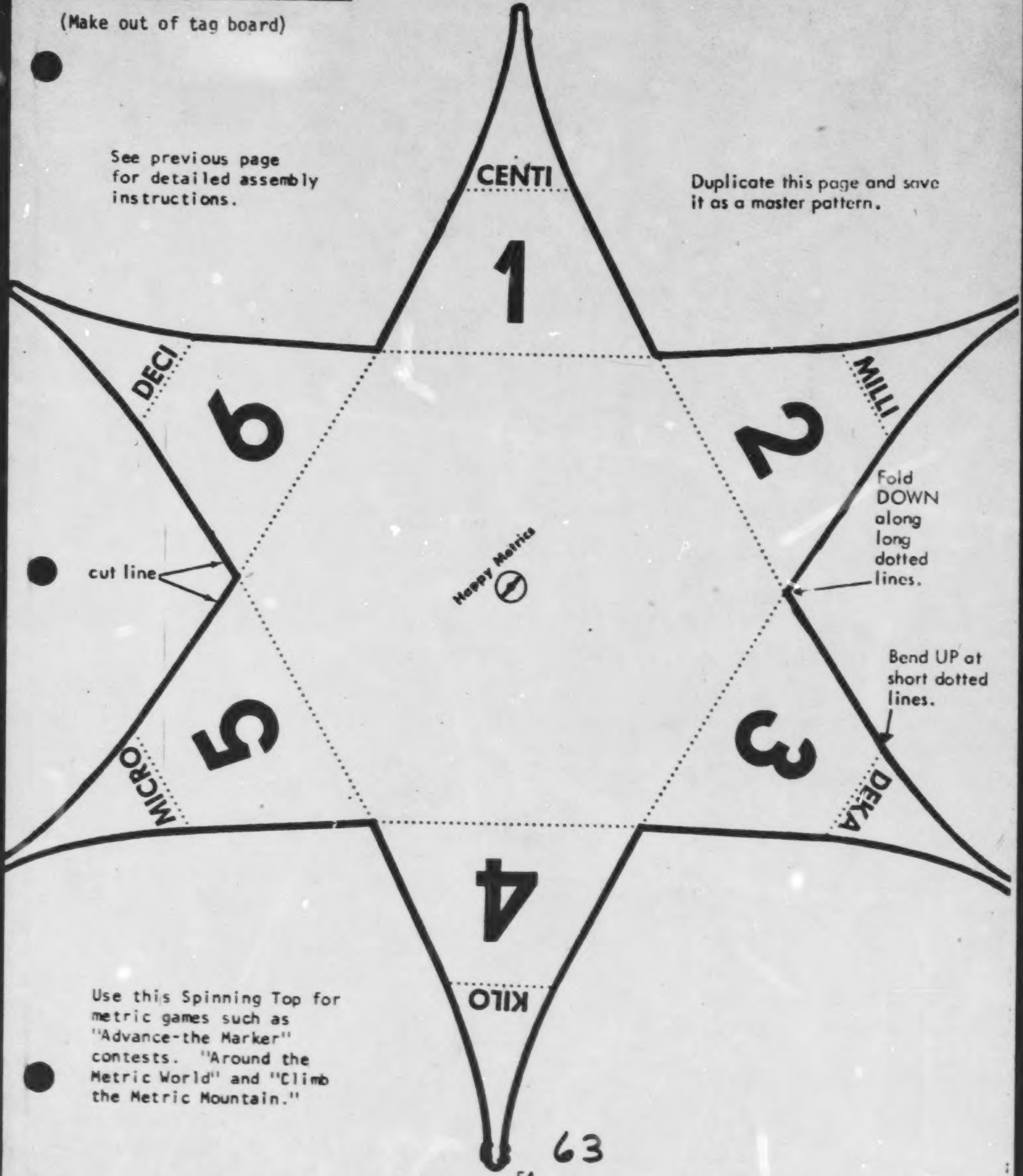
CONSTRUCTION PROJECT

SPINNING TOP FOR METRIC GAMES

(Make out of tag board)

See previous page for detailed assembly instructions.

Duplicate this page and save it as a master pattern.


CENTI
1
MILLI
2
DEKA
3
KILO
4
MICRO
5
DECI
6
Happy Metrics
cut line

Fold DOWN along long dotted lines.

Bend UP at short dotted lines.

Use this Spinning Top for metric games such as "Advance-the Marker" contests. "Around the Metric World" and "Climb the Metric Mountain."

CLIMBING LINE

2 - 4 Players

MATERIALS: CLIMB THE METRIC MOUNTAIN
Spinner
Centimeter ruler
40 cm string
Game markers, bottom of page

GAME OVERVIEW

Each player places a game marker in the START REGION of his/her climbing trail. Spinner indicated the number of centimeters a mountain climber can advance up his/her trail.

INSTRUCTIONS

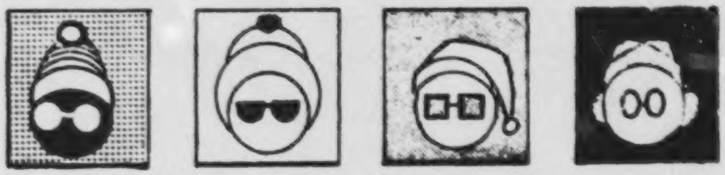
PLACE GAME MARKERS in the start region of a climbing trail.

STARTER BEGINS by spinning the spinner. The spinner indicates the number of centimeters a mountain climber can advance up the trail. Use a centimeter or ruler to determine how far to advance a marker. The string may be useful to measure the distance around the turns.

WINNER is the first climber to reach an "I WIN" space.

VARIATION: Attach a climbing line (string) to a mountain peak, with a tack. Have climber advance to the peak along the climbing line.

GAME MARKER CUT-OUTS



Paste a duplicate of these markers onto card stock or tagboard.

SI PREFIXES

PREFIX	MULTIPLYING FACTOR	SYMBOL
tera-	10^{12}	T
giga-	10^{9}	G
mega-	10^{3}	M
kilo-	10^{3}	k
hecto-	10^{2}	h
deca-	10^{1}	da
deci-	10^{-1}	d
centi-	10^{-2}	c
milli-	10^{-3}	m
micro-	10^{-6}	μ
nano-	10^{-9}	n
pico-	10^{-12}	p
femco-	10^{-15}	f
atto-	10^{-18}	a

WORLD WIDE CONVENTIONS

The International Organization for Standardization Recommendation R1000 (1969)

SYMBOLS:

mm, cm, dm,	meter,	m, dam, hm,	km
ml, dl,	liter,	l,	kl
mg,	gram,	g,	kg

A symbol is not an abbreviation; not followed by a period, not pluralized, has a space between numeral and symbol, e.g., 152 g

DECIMAL NOTATION

Spaces, not commas, between periods of 3 digits, e.g., 6 946 572

Decimal point is period or comma

Initial zero before decimal point for numbers < 1. e.g., 0.54, 50.75

CHAPTER TWO

THE METRIC MEASURE OF AREA

INTRODUCTION

This chapter deals with various activities relating to the measurement of area.

The concept of area is not easily understood by young children. Care must be exercised if introducing this concept to the lower grades, it should be limited to drawing squares, cutting out geometric figures, the building up of geometric figures out of square centimeters, measuring in centimeters and millimeters the perimeter and similar activities.

Activities in this chapter relating primarily to the younger children are: "Guess the Measure", "Measure Machine Man", "Student Activity", and "Square Meter".

For the older children, in the upper elementary grades, activities more suitable would be "Rectangles, Triangles, Parallelograms", "Measure Mass to Find Area", "Scaling Up: Making Larger Drawings", "Area: From Counting Squares to Finding Formulas".

AREA

This section is on metrics dealing with area in sq. mm. This section will give the student instructions on how to determine areas of irregular shapes and triangles.

GENERAL OBJECTIVES:

1. To give the student practice in measuring objects in sq. mm.
2. To give the student working knowledge using the formulas for determining the areas of squares, rectangles, triangles and combinations of these figures.

ACTIVITIES:

1. Introduction of area of study. (Go over the metric system.)
2. "Guesstimation": Objects to use stamp, post card, envelope, eraser. Have the students guess the length and the width. Now measure the objects.
3. Give the formula of determining area of a square or rectangle. (LxW) Use the figures (1a). Make sure that the student counts the whole square not just the perimeter but the area inside the perimeter.
4. a. Formula for determining area of a triangle (L x W/2). Use figure 2a. If the student does not understand the above concept then use a square, divide the square diagonally to form two equal triangles.

   b. Now use the figure (3a) to see if the student can determine the area of this figure.

5. Area of the flea potato garden.

   a. 100 flea potato plants

   b. 10 plants to a row 10 rows

   c. Plant them 10 mm apart

   d. The plants must be planted in the middle of the squares.

   e. The rows of plants on the outside perimeter (L and W) need only 5 mm to the edge of the garden.

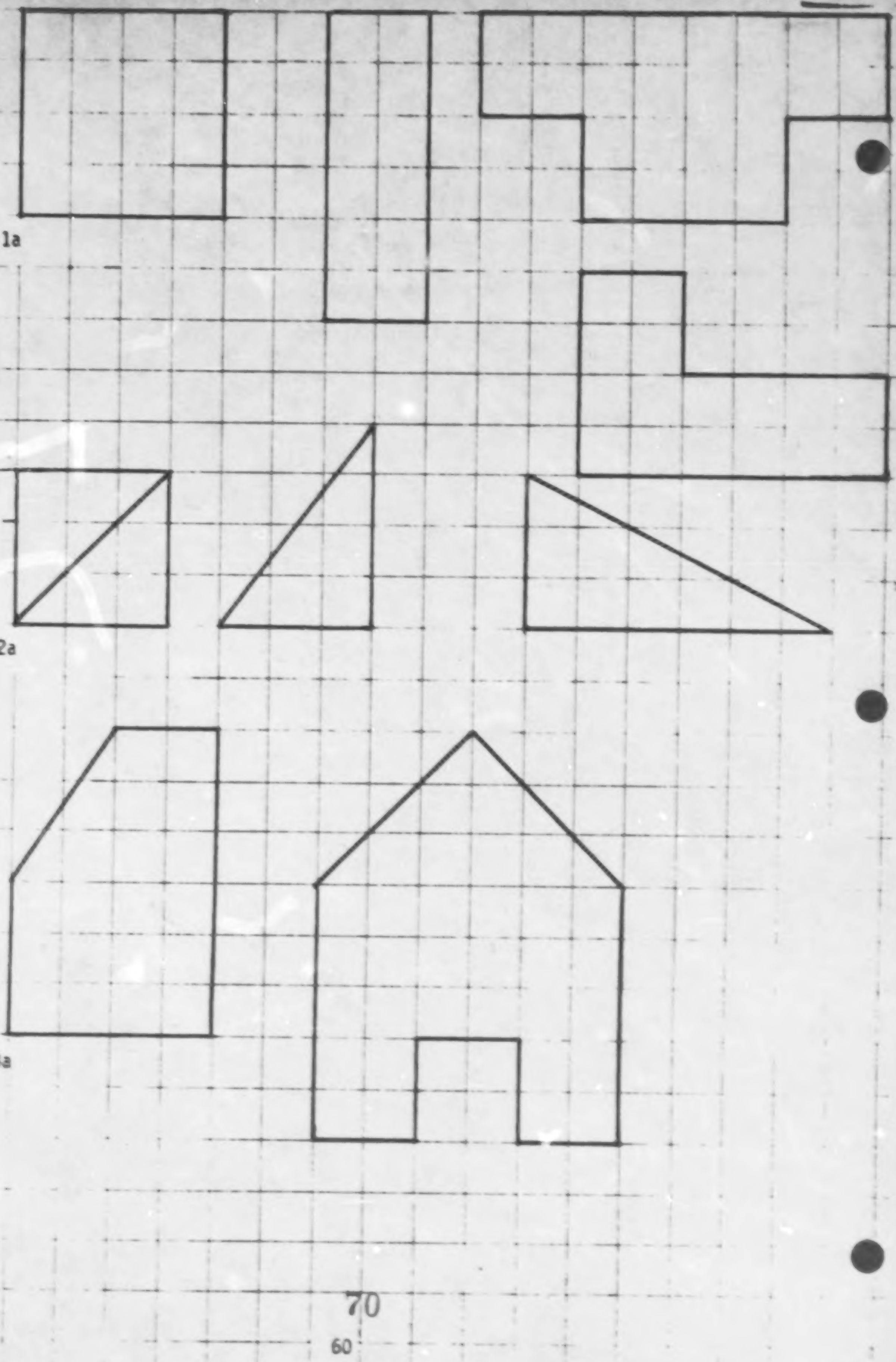


Figure 1a

Figure 2a

Figure 3a

AREA CENTIMETERS

This section deals with activities relating to area in centimeters. It also includes a developmental sequence of activities dealing with area which can be adapted to metrics.

GENERAL OBJECTIVES:

1. To provide an introduction to measurement in area.

2. To provide a developmental sequence of study related to the concept of area.

3. To increase the student's ability to use centimeters when figuring area.

COMMENTS:

The first section in area presents a developmental sequence of activities that should be followed when presenting area. These activities should be enriched by incorporating metric measurement. The second section consists of activities directly related to area in centimeters.

CONCEPT III: AREA

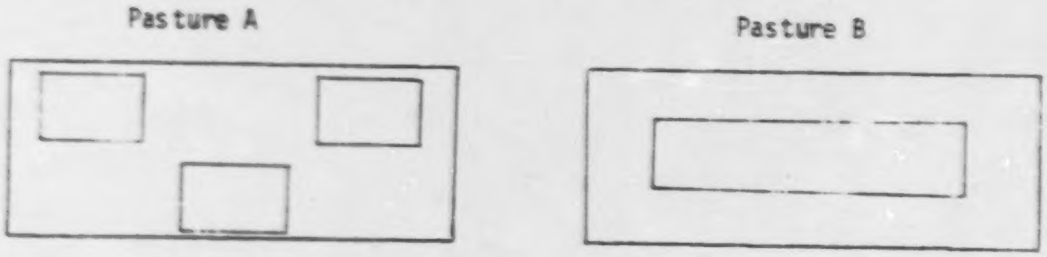
LEARNING LEVEL A: CONSERVATION

1. Have the student arrange 48 paper congruent squares on a table so that they form two large rectangles composed of 24 squares each. One rectangle could then be rearranged so that all the squares were spread out. Ask the student which group covered more of the table, the one remaining in a rectangle or the one that was rearranged.

2. Construct four different-shaped rectangular regions, each of which has the same area of 24 square units. This may be done on coordinate paper or on a geoboard. (To relate to length, ask students to find the perimeter of each of their rectangles.)

3. Provide a student with 16 right triangles cut from paper all the same size and shape. Ask the student to put them in two piles so that each pile has the same number of triangles. Have the student place the triangles from one pile next to each other on the table so that he builds some kind of "shape." Ask him to build a different shape with the triangles from the other pile. Do the two shapes have the same area? If the answer is "yes," ask (1) for an oral explanation, and (2) show they are the same by rearranging the triangles in one of the shapes to match the other shape, or by putting the triangles from one shape on top of the triangles in the other shape.

4. The "Fields of Grass" problem:



Pastures A and B are the same area. The three equal barns on pasture A when placed together are the same area as the one barn on pasture B. Which pasture has more grassland? (Illustrations can be done with drawings, cut-outs, felt board, etc.) What would you do to prove your answer?

CONCEPT III: AREA

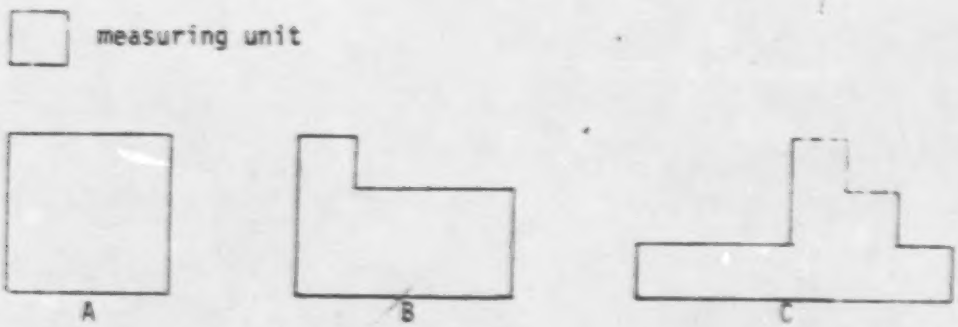
LEARNING LEVEL B: COMPARISON

1. Have each student draw an outline around his hand or foot on a piece of paper. Have him compare the size of his hand with the size of classmate's hand. By holding the two outlines against a window pane, placing one over the other, students can accurately compare size of their hands or feet with those of their classmates.

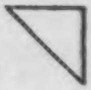
2. Distribute a picture to each student. On the picture have the student circle some specific items; e.g., the largest ball, smallest person or a small house. Next, have the student find larger or smaller items of the same kind in other pictures. Have the student explain the choices to the group.

3. The following activity involves comparison of area by counting how many small squares (or triangles) there are in the larger regions. The child should be given a cardboard unit square and a cardboard unit triangle. He will place the measuring unit on the drawings, mark off the area by tracing around it with a pencil, and count the number of units in each region. He then can order these three regions from smallest to largest to smallest.

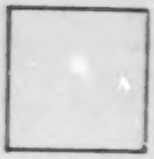
Sample 1:



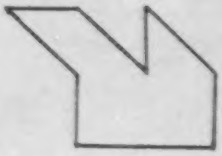
Sample 2:



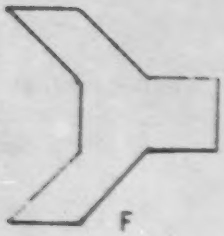
measuring unit



D



E



F

CONCEPT III: AREA

LEARNING LEVEL C: UNIT CONCEPT

1. Determine the area of a table top in terms of sheets of paper, linoleum tiles, erasers, newspapers, books, towels, notebooks, blankets, etc. Discuss the advantages and disadvantages of the various units used.

2. Determine the area of a table top in terms of rectangular sheets of paper, squares, triangles, trapezoids, circles, pentagons, irregular shapes, etc. Discuss advantages and disadvantages of the various units used.

3. Determine the area of a table top, the floor, a notebook cover and the school grounds in terms of little squares, middle-sized squares, large squares. Discuss the advantages and disadvantages of the various units used.

4. How many sheets of newspaper would be needed to paper the floor, or the walls of the room? a football field? the school grounds?

5. Supply students with precut figures including various sizes of shapes appropriate to the learners, such as squares, rectangles, triangles, parallelograms, trapezoids, circles and irregular combinations of these.

The figures may or may not utilize whole number dimensions, according to the needs of the group. The cut-outs may be of cardboard, tagboard, plastic, etc. Students also need graph paper. Ask students to choose a unit of area and designate it by outlining "one unit" on their graph paper. Place the cut-out figures on the graph paper, and draw around the various shapes. Count the number of their chosen units enclosed by each boundary. This will probably create a problem for some discussion and decisions about approximating and the need for a common unit. This also presents an opportunity for estimating, then counting. An alternate activity may be to ask students to outline or draw a number of shapes all having the same area.

6. Each team of students selects an arbitrary nonstandard unit to measure the area of the floor and the area of the teacher's desk top. Teams will decide if they want to use the same size unit to measure both areas. After determining the two areas, each team will prepare a letter in which they place an order to a supplier for carpeting and formica. The letters will then be read to the other teams to see if there is suitable information to fill the orders. When students discover a lack of communication (the need to use standard units), they will be asked to develop a plan for meeting the communication gap.

CONCEPT III: AREA

LEARNING LEVEL D: STANDARD UNIT

1. Supply students with precut figures including various size shapes appropriate to the learners such as squares, rectangles, triangles, parallelograms, trapezoids, circles and irregular combinations of these. The figures may or may not utilize whole number dimensions. The cut-outs may be card-

board, tagboard, plastic, etc. Students also need graph paper-centimeter scale. Ask students to outline a unit of 1 cm^2. Place the cut-out figures on the graph paper and draw around the various shapes. Count the number of units enclosed by each boundary. Students will be faced with some approximating. Encourage the students to estimate before measuring. A follow-up activity may be to ask students to develop mathematical expressions which express the area in terms of dimensions; e.g., $A = LxW$ for the area of a rectangle.

2. Centimeter graph paper will be needed. Students trace the outline of their hand on the paper, then find out how many square centimeters are covered by their hand. Discussion will bring out some thinking about approximating. Trace around a cube on the graph paper and determine the area of one face of the cube. Does it matter how you place the cube on the graph paper? What is the total area of all faces of the cube?

3. Students may construct their own "area ruler" (area grid) to use for measuring area. Construct a centimeter scale grid on a sheet of clear plastic. A unit is one of the squares, 1 cm by 1 cm. By placing this sheet on various drawings, the areas may be found by counting the squares within the boundary. The drawings may include squares, rectangles, triangles, parallelograms, trapezoids or combinations of these which form irregular shapes.

4. This activity involves Cuisenaire rods, but only 2 to 4 "ten rods" and only 5 to 15 "one rods" should be provided. Use the rods to discover a plan for finding the area of the bottom of several boxes which are small rectangle, or squares whose dimensions are each 55 cm or less.

This activity may also be done with cardboard cutouts. Five to 15 squares 1 cm by 1 cm and 2 to 4 rectangles 1 cm by 10 cm are needed. The small boxes may be used again or drawings of rectangles and squares will serve. The more adventurous leaders may rise to the challenge of developing a plan for determining the area of triangles, parallelograms, trapezoids, etc.

CONCEPT III: AREA

LEARNING LEVEL E: APPLICATION

1. Supply students with precut figures (or actual size drawings) including various sizes of shapes such as squares, rectangles, triangles, parallelograms, trapezoids, circles and irregular combinations of these. The figures may or may not utilize whole number dimensions. The cut-outs may be cardboard, tagboard, plastic, etc. Students also need metric rulers. A decision must be made as to whether to provide formulas to the students. Ask the students to measure the figures, then calculate the areas. A follow-up activity may be to ask students to construct as many rectangles as possible having an area of 24 cm^2 with a length which is a whole number of centimeters. Determine and compare the perimeters of these rectangles. Another follow-up activity may be to construct rectangles of the greatest possible area and the least possible area, each having a perimeter of 16 cm.

2. Play "Mystery Measurements" game using area measurements.

3. Each team of students will develop a redecorating plan for their classroom. Choosing appropriate metric measuring devices and units, each team will measure and determine the materials needed to do the following 1) carpet the floor, 2) paint the walls and ceiling, 3) prepare drapes for the windows, and 4) cover the teacher's desk and a classroom table with

formica. Try "telephoning" their order for materials to another team to see if communication is possible.

4. The student is asked to determine the area of an irregularly shaped object such as leaves of various trees or shrubs. Find the mass of a sheet of graph paper. Determine the number of squares on the page. Then calculate the mass for one square. Trace the leaf pattern on the graph paper and cut it out. Now find the mass of the cut-out and compare it to the mass of one square to determine the number of squares covered by the leaf. (Be alert for possible confusion between the quantities of mass and area when mass measurements are being used to determine area.) Compare the results found by this method to those determined by counting the squares inside the outline of the leaf.

Function of estimation
Metric units and prefixes
Useful activities
Do you "THINK METRIC?"

5. A pre-test and a follow-up post-test may be used to compare levels of competency before and after the workshop. Learning theory as well as content should be considered.

SAMPLE ACTIVITY

The following activity is offered as one example of the kind of "hands-on" experience that can be used to teach measurement. It is important to note that the series of activity steps encompasses all five levels of the measurement learning approach while working only with the concept of length.

1 cm grid

1. Using a cm^2 grid consider the area of your hand.

Estimate __________ cm^2

2. Place your hand on a cm^2 grid; outline in pencil from wrist joint around to wrist joint. Determine area as precisely as you can by counting squares.

Area ______________ cm^2

3. Compare results.

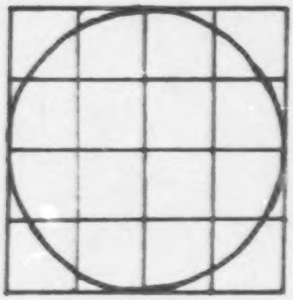
Error ______________ cm^2

4. By drawing these shapes on a cm^2 grid, and counting squares, determine the area of their interior regions:

   a. A rectangle 5 cm by 3 cm ________________ cm^2

   b. A right triangle with sides 5 cm, 12 cm, and 13 cm ________________ cm^2

   c. A circle inscribed in a square, 4 cm by 4 cm ________________ cm^2



AREA: Counting Squares

This sheet starts the student on the first of what should be a wide variety of manipulative experiences with measuring square centimeters by counting them and working with them.

General Objectives:

1. Give the student experience with areas which are equal even though the shapes are different.
2. Have the student draw areas to meet a size specification, in order to improve his concept of exactly what area means.
3. Provide practice in measuring and in drawing skills.

Comments:

Most people's ability to estimate size is really restricted to length. Students in general will tend to consider area or volume in terms of the length of the longest side, until they have had a good deal of experience or mathematical sophistication. Actually working with areas, drawing them, coloring them, cutting them out and putting them together in different forms (in somewhat fancy terminology, "experiences with conservation") are all valuable and necessary to develop the concepts students will need.

Other drawing activities, in particular, are easy to assign, can be fun to do, and are attractive for bulletin boards. One bulletin board could be nicely set up, with a border of 1-meter of the mylar tape on each side (the black on yellow 100 cm tape makes an attrative visual frame) as a "Square Meter of Art". Since each grid sheet has 500 square centimeters, it would take 20 such student sheets to fill the square meter. This provides an excellent way to demonstrate some large numbers, counting centimeter squares by hundreds, and then by thousands, to arrive at the 10.000 cm^2 = 1 m^2.

You can also use the area tablet sheets provided in the kit for the students to see the concepts of squares and their area. The brightly colored sheets give 10 cm by 10 cm, 5 cm by 5 cm, 4 cm by 4 cm, 3 cm by 3 cm, and 2 cm by 2 cm squares, and also provide one sheet which you may cut apart into any sizes you find most convenient. -- If you wish, you can laminate the sheets in plastic to make them extra-heavy weight and durable. (Patterns are also provided for cubes, to be used later as demonstration models.)

AREA: Guess, then Measure

This sheet motivates measurement of area by appealing to everyone's desire to see how well he can guess.

General Objectives:

1. Provide more practice in measuring area by counting squares, with an introduction to the idea of doing some calculating.

2. Provide experience with triangles, reminding students that a triangle is half of a rectangle, by the illustration.

Comments:

Students who know how to multiply could be encouraged to calculate the areas of the rectangles after measuring length and width, and to do the same for the triangles. Actual manipulative experience using the overlay grid, however, should not be prematurely dropped. Even if the students calculate area, they should also have the visual reminder that they are, after all, counting squares in doing their calculations. The computation is just a "short way to find how many squares".

Other activities:

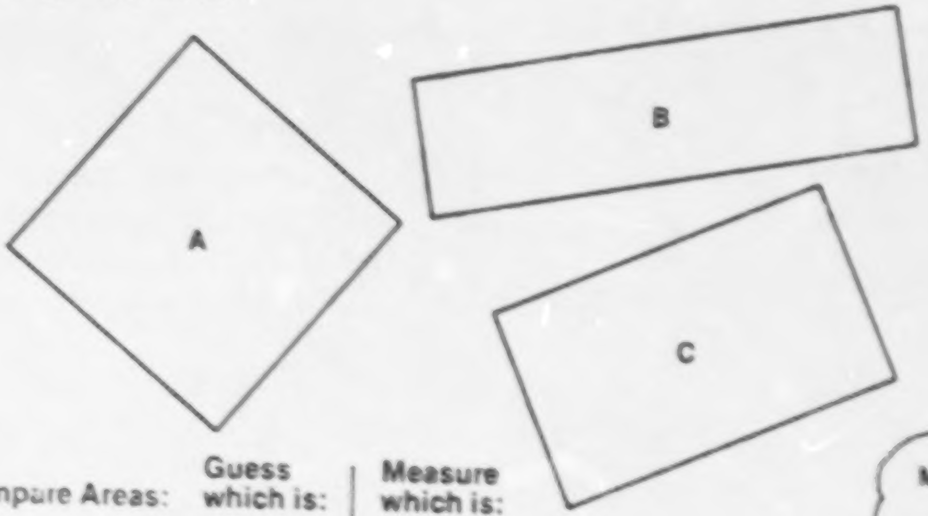
Assignments to make designs, with specifically stated number of square centimeters in named colors, are good. Such assignments provide well for individual differences. Where the average student may tend to work in blocks of rectangles, the more imaginative may use disconnected regions or go to other shapes. Then, as the designs are posted on the bulletin board, other students may get ideas from them. Or groups of students may cooperate to make a joint design which requires more than one sheet for its display. Students can "carpet" a square meter on the floor with a design on a large sheet of paper. Separations of the large sheet into decimal parts can again illustrate place value, 1 cm^2 = 0.000 1 m^2, for students who are ready for such experiences.

Students can use the area squares provided to shorten their count of square centimeters, by using 100 cm^2 blocks or smaller ones to finish the count of a rectangular region. (For example, on their centimeter grid paper, 4 large blocks reinforces counting in hundreds, then either the 5 cm by 5 cm or 1 cm by 10 cm pieces cut from the colored grid sheet could finish the count.)

AREA:

Guess, then Measure

First try to guess which rectangle has the largest area, which is next, which is smallest. Then check your guess by using the plastic grid to measure, and fill in the letters in the chart.



Compare Areas:	Guess which is:	Measure which is:
Biggest?		
Next?		
Smallest?		

Measured Areas

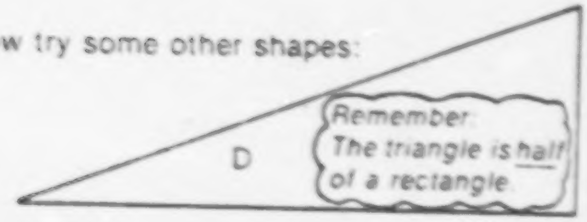
about

A ______ cm²

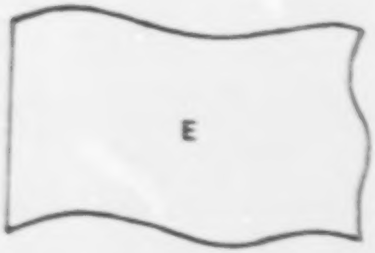
B ______ cm²

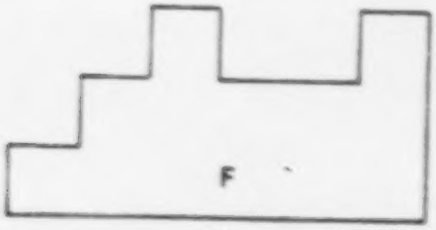
C ______ cm²

Now try some other shapes:



*Remember:
The triangle is half of a rectangle.*





Areas	Guessed	Measured
Biggest?		
Next?		
Smallest?		

Measured Areas

about

D ______ cm²

E ______ cm²

F ______ cm²

MEASURE MACHINE MAN

This is an example of an individual activity sheet, which gives students some measurement practice in a relatively interesting way.

General Objectives:

1. Provide some practice in measurement, both linear and area.
2. Encourage the students who may be ready for it to calculate areas.

Comments:

No instructions are provided on this sheet on how the student is to find the areas. This leaves it completely up to the individual student to decide what method he wishes to use. All dimensions "come out even" in unit squares, so use of the overlay sheet will work beautifully for those students who wish to do the problem that way. -- For the first time, a question is posed in this sheet to encourage verbalization of a formula for finding area. It is not given with a blank to fill in, so that the student who cannot answer the question is not disturbed by his inability. Rather, the question is simply advanced, for the student to think about.

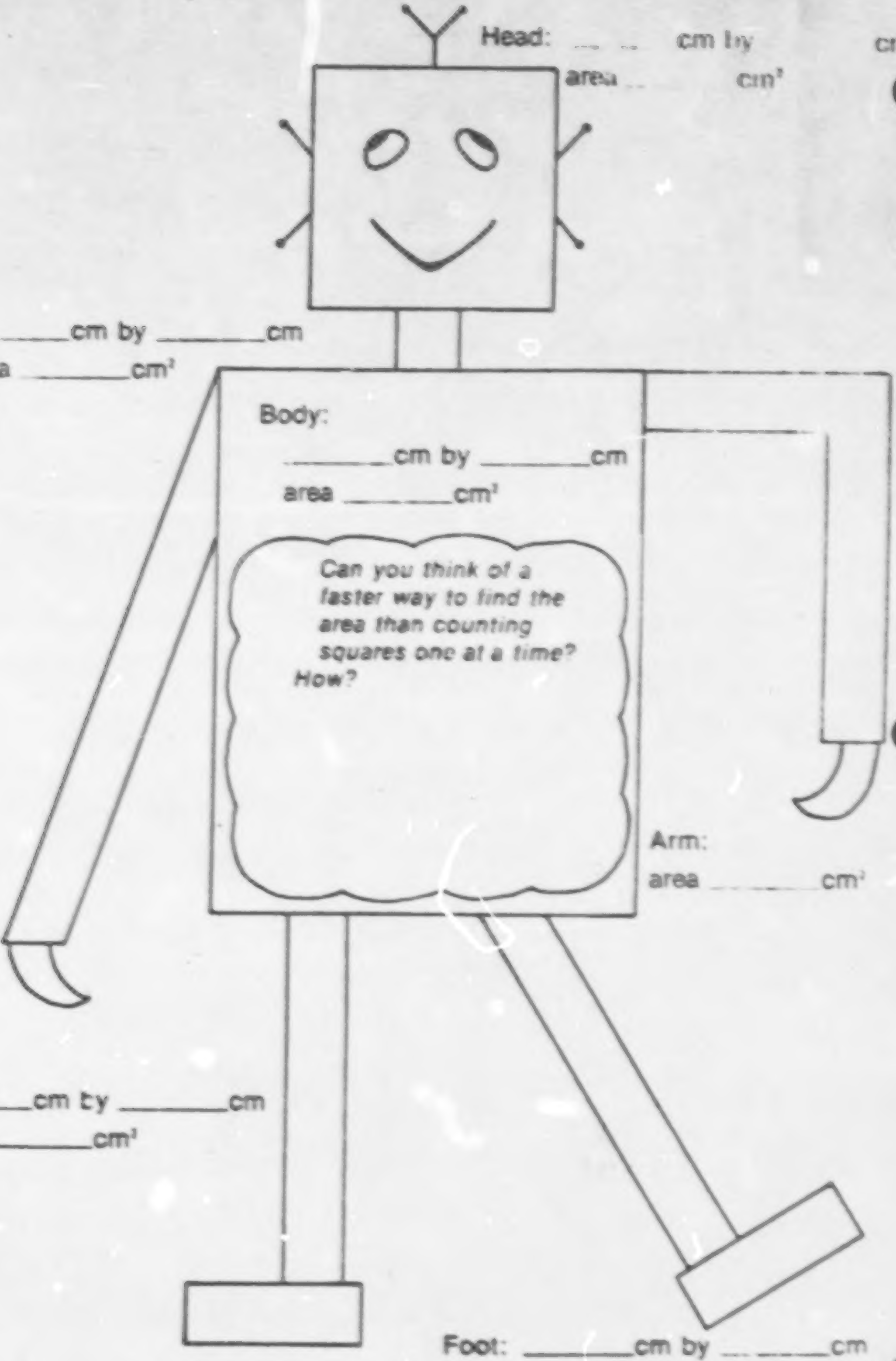
After the questions are answered, the students could be encouraged to color the picture in any way that suits their fancy. -- Some students might like to draw other block-pictures, which could serve as similar puzzle-type problems. (Suggest that they do their original pictures on the grid paper, then trace over onto a plain sheet.)

Other Activities:

Students could use the floor plan and find areas of various rooms. They should check area of three of the rooms, all of which have measurements that come out even; some of the other rooms will have half-squares.)

More advanced students could use the map of the United States to calculate areas in square kilometers, for states which are essentially rectangular in shape. -- This is only for the most mature students, however. (This activity is adapted from a suggestion by J. Semenza)

MEASURE MACHINE MAN



Head: ______ cm by ______ cm
area ______ cm²

Neck: ______ cm by ______ cm
area ______ cm²

Body:
______ cm by ______ cm
area ______ cm²

Can you think of a faster way to find the area than counting squares one at a time? How?

Arm:
area ______ cm²

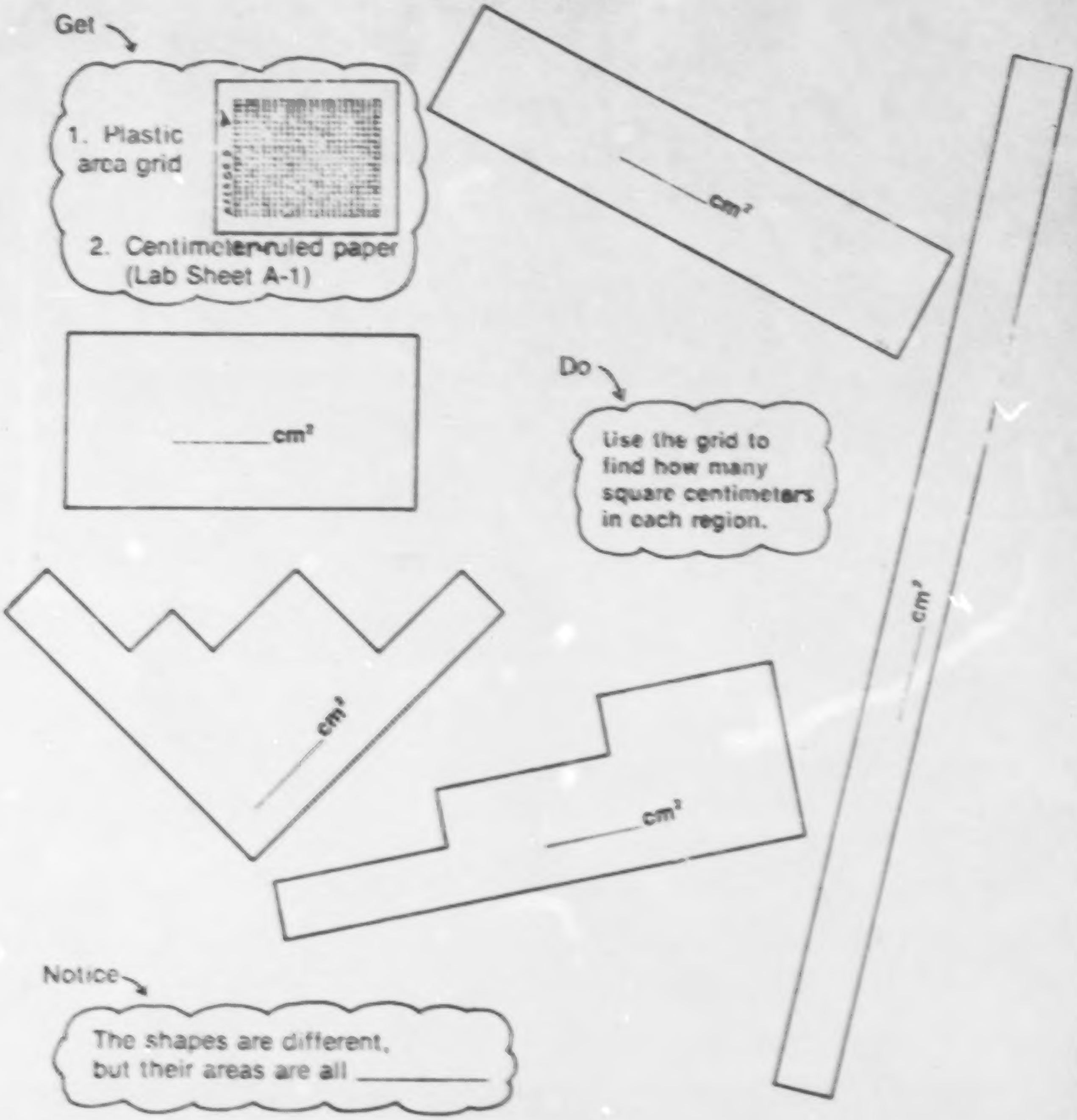
Leg: ______ cm by ______ cm
area ______ cm²

Foot: ______ cm by ______ cm
area ______ cm²

AREA:
Counting Squares

Get

1. Plastic area grid
2. Centimeter-ruled paper (Lab Sheet A-1)



Do

Use the grid to find how many square centimeters in each region.

Notice

The shapes are different, but their areas are all __________

Do

Use the centimeter paper to draw 5 different shapes each of which has area = 12 cm²

and Do

Make 3 area questions for the Answer Machine.
Show them to your teacher.

AREA: Rectangles, Triangles, Parallelograms

This sheet formally introduces the word congruent to describe figures which are the same size and shape, and proceeds to some experiments with two congruent rectangles and a parallelogram with the same base and height as the rectangles.

General Objectives:

1. Provide manipulative practice (draw, cut, fit) with area of regions.
2. Lead the student to discover the relationship of areas of rectangles, triangles, and parallelograms in terms of base and height (without any formalization).

Comments:

First the student constructs a parallelogram directly from a rectangle by moving a triangular region to the opposite side. Since the pieces are the same, the areas must be the same. Then an experiment extends the concept to triangles. The student has already worked with the triangles as half of the rectangle; now he finds it is also half of the parallelogram, by a different rearranging of parts.

The last experiment has the student try to figure out what line he could draw to make a cut in order to form an equivalent rectangle out of his triangle-parallelogram pieces. This leads to the idea of the height.

Again, an extra copy of the sheet would be valuable for the student's notes.

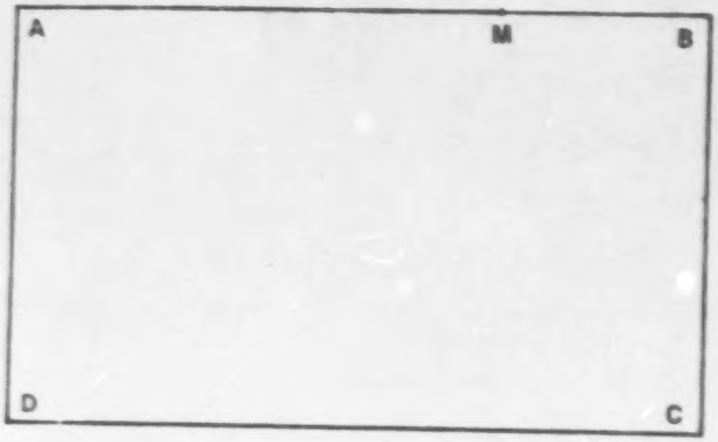
Other Activities:

Give the student experience in drawing any triangle he wants to (fairly large sizes would be nice to use). He should make at least two copies of his triangle, then cut one of them in the proper way (height from vertex to a base) so that he can assemble the pieces, together with his first triangle, into a rectangle. If he now makes still another copy, have him try a different cut (to a different base) which will also make a rectangle. -- Encourage the student to draw acute triangles for this project; if he does he can learn that three different heights exist along which he can cut to make rectangles of equal area. This will avoid a student misunderstanding which is quite common, thinking of "the" base of a triangle, as if only one existed.

AREA:

Rectangles **Triangles** **Parallelograms**

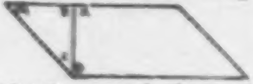
More Experiments



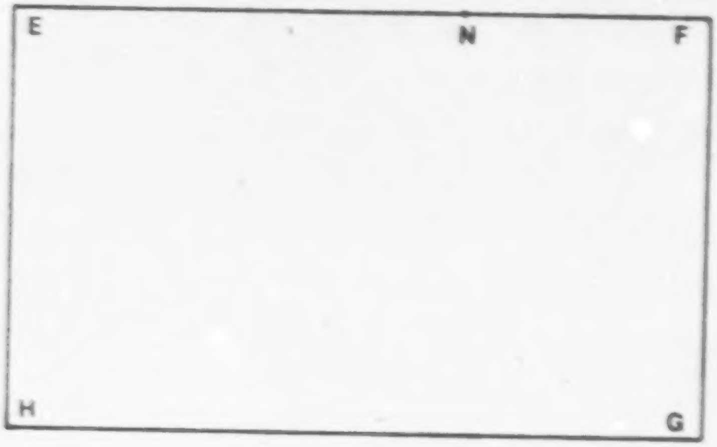
The two rectangles on this sheet are congruent (same size and shape).

Each measures ______ cm by ______ cm and has an area of ______ cm².

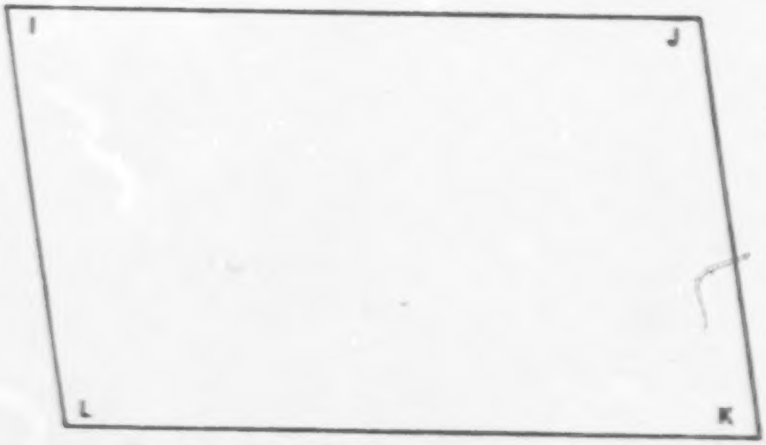
1. Draw $\overline{CM}$. Cut out the rectangle and triangle MBC. Now move $\triangle MBC$ so edge BC is along AD as shown.



The figure you made is called a parallelogram. It is not congruent to the rectangle, but it ______ (does, doesn't) have the same area.



2. Draw $\overline{HN}$ and $\overline{GN}$. Cut out the 3 triangles. The area of $\triangle HNG$ is ______ of the rectangle area, or ______ cm². Can you put the 3 triangles together to make a parallelogram? ______
Which segment connects opposite corners of your parallelogram? ______
That segment cuts your parallelogram into two triangles.
$\triangle$ ______ and $\triangle$ ______



3. Draw $\overline{LJ}$. Cut out parallelogram IJKL and the two triangles. Are the two triangles congruent? (Try to fit one on top of the other) ______ Then the area of each triangle must be ______ of the area of the parallelogram.

4. Can you draw a line from J so that cutting on that line you can re-arrange your pieces into a rectangle? ______ Do it. The area of your rectangle equals the area of the parallelogram which used the same pieces, so the area of the parallelogram is ______ cm².

MEASURE MASS TO FIND AREA: An Experiment

This sheet continues the study of indirect measurement with a refinement of the technique so the student can do an actual measurement of square centimeter in a region.

General Objectives:

1. Reinforce the student's concept of area as counting squares and its extension to general regions of surface.

2. Give the student further experience in making "standards" for measurement purposes, against which unknown quantities can be checked. (In this case he makes area standards.)

3. Extend the student's experience with experimental work and the idea of recording laboratory results in some kind of chart.

Comments:

The mass measurement made in part (2) is not needed for the student to complete his chart in (5), in all likelihood, but it leads to further thought and the possibility of an extension of the method he has used (as suggested, though not required, in (6)).

If further leads, for the more mature students, to the thought question posed at the bottom of the page, which would involve calculations (this is only for students who already are familiar with multiplication and division, and can do the analytical thinking required to solve this problem).

Other Activities:

Certainly the strips the student constructs in the first part of the experiment (10 cm^2) could be further subdivided into 1 cm^2, as some of your students may observe for themselves. A good deal depends on what kind of material they use for their areas. Heavier weight stock will make it practical to do closer area measurements.

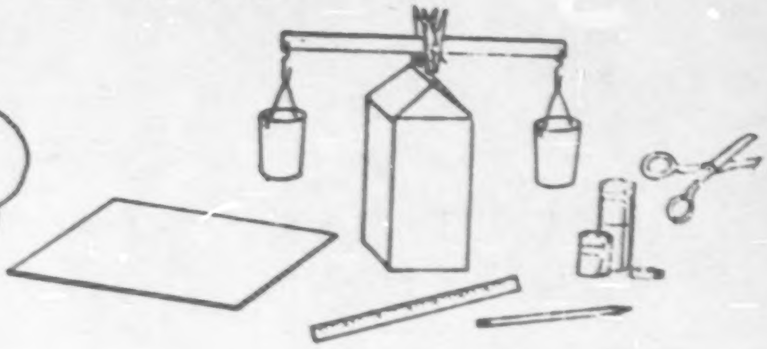
If you wish, you can help your students discover some relations about the area of circles by having them use compasses to make circles of different radius lengths, then comparing them to squares whose sides are a radius length. In each case they can observe that it takes more than 3 squares to balance the circle.

MEASURE MASS TO FIND AREA:

An Experiment

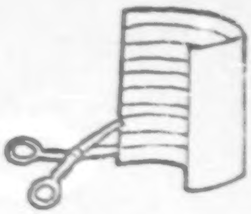
You need:

thin cardboard or heavy paper
pencil, ruler and scissors
balance scale and masses



Do:

1. Draw a square 10 cm by 10 cm on the cardboard.
2. Cut out the square and find its mass.
   100 cm^2 area = ________ g
3. Cut your square into 10 strips, each 1 cm wide.
   Each strip has an area of ________ cm^2.



4. Use the same cardboard as you used in (1). Draw any 3 patterns you want on the cardboard. Cut them out. Mark your 3 unknown regions D, E, F.

5. Balance each unknown region against the strips you cut. Count how many square centimeters you need to balance each region, and fill in the chart.

Region	Area
D	________ cm^2
E	________ cm^2
F	________ cm^2

6. If one of your regions is so big that you can't balance it even if you use all your strips. Start over on the balancing with enough masses from the kit to equal the mass you found in (2), which would balance an area of ________ cm^2. Then add strips until you have enough to balance. Your answer will be the ___________ of the strips and 100 cm^2. (If you want, try a new region that would need this method. Call it G and add it to the chart.)

Maybe you can think of another way to find the area, by using the facts in (2) and simply measuring the mass of each region. Can you? If so, put your work on a chart like this one.

Region	Mass	Area
D		
E		
F		

SCALING UP: Make a Larger Drawing

In this sheet, we have a picture of a house, all of whose horizontal and vertical dimensions are in centimeter or half-centimeter lengths, which the students are asked to copy in 2:1 scale enlargement, using centimeter ruled grid paper.

General Objectives:

1. Provide more experience with scale drawing, extending the process to a somewhat higher level of abstraction.

2. Lead the student to discover that when linear dimensions are in 2:1 scale, areas will be 4:1.

Comments:

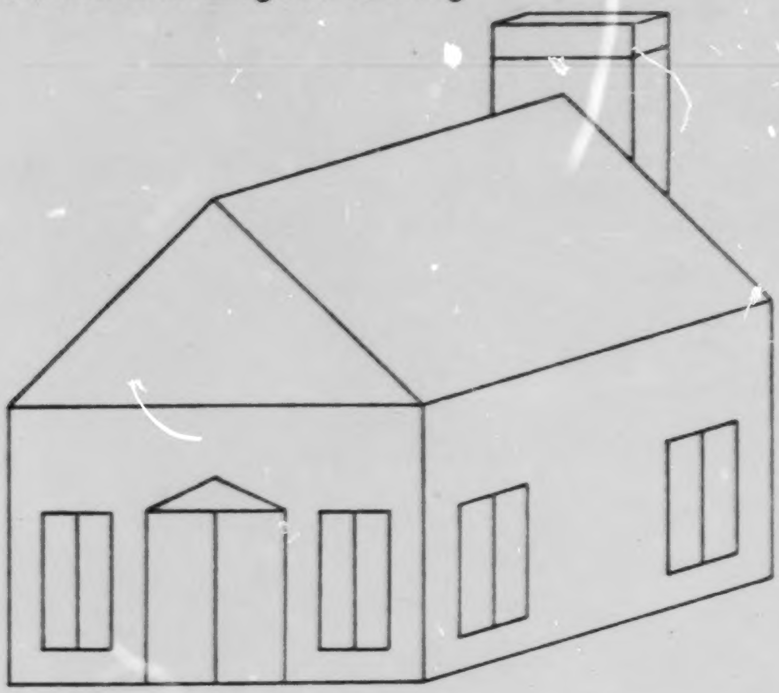
Actually, the students have already done a 2:1 enlargement, but not with those instructions. At that time they simply used a 1:50 scale with a printed scale ruler, and finished with a picture which was an enlargement of a room in the floor plan. This assignment explicitly introduces the idea of scale ratio and has the student responsible for figuring out exactly what he is to do, with a good deal more independence and less guidance in the directions. This is probably not appropriate for most students below 5th grade level.

You might suggest to the students that they superimpose a transparent overlay grid on the house picture to make their enlargement job easier. Then if they start copying the picture by placing the lower left-hand corner at the appropriate corner of their centimeter paper, the rest of the work will go more smoothly. They can use the overlay sheet again to measure the areas involved in both pictures.

Other Activities:

Once students have done a scaled-up copy like this, the same overlay-and-grid approach can be used more readily for other such drawings. If you change to a more complicated scale, be sure to use a simpler figure. The relation between linear and area measurements of similar figures can be understood by the students much better after some practice of this type. They will see that the area varies as the square of the linear dimension (not in those abstract terms, but just in specific numerical ratios). Use rectangles in 2:1, 3:1, 5:1 linear proportion.

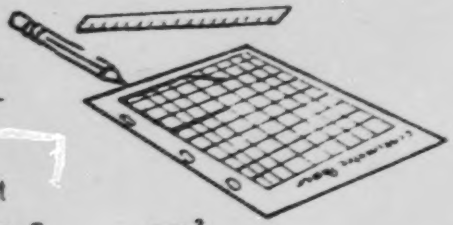
SCALING UP: Make a Larger Drawing



Here is a drawing of a house. You can copy this drawing on the centimeter grid paper, making your picture larger.

Use a scale 2:1. That means every measurement in your picture will be twice the measurement shown here. (Example: the door measures 2.5 cm high, so your door will be 2.5 + 2.5 = ________cm high).

Your drawing will almost fill the grid sheet, which you will have to turn sideways, like this.



What is the area of the front wall in the picture on this page? ______cm²

What do you think it will be in your picture? ________cm²

Find out what it really is, after you draw your house. ________cm²

Check some other areas on the pictures.

	Yours	This Sheet
window	______cm²	______cm²
door	______cm²	______cm²

If lengths are 2:1, then areas are ____:1

AREA: From Counting Squares to Finding Formulas

For the students who know how to multiply, this lab sheet develops formulas for area of rectangles and triangles, building on the base of their previous measurement and manipulative experience.

General Objectives:

1. Provide practice using formulas to find area in square meters, square centimeters and square millimeters.
2. Introduce rationale of exponent use as multiplication.
3. Reinforce idea of units in measurement.
4. Provide practice with algebraic symbolism, both in use of letters and use of fractional notation for division.

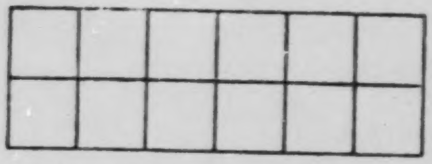
Comments:

The formula is motivated as a short way of writing instructions to get a desired result (like a recipe), and the algebraic notation as a further abbreviation of the instructions. Units are mentioned explicitly in connection with the multiplications which result in exponents (i.e. $m \times m = m^2$). Such an introduction to exponents will be helpful to the student in his later work, which will then be a natural extension of something he has already become familiar with. If you like, you can go one step further in the abbreviated symbolism by showing the students the usual algebraic convention that writing quantities without an intervening symbol indicates multiplication. Thus $A = LW$ means Area = length times width. (Students rather like to feel superior to the text material they are using: if you can show them the next step in the symbolism and tell them they can use it if they want to, they are likely to want to.)

Further Activities:

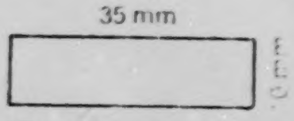
More practice in measurement and area problems is simple to provide. You could have students make up question cards with area problems to solve and cards to emphasize unit and exponent aspects. You can have them draw rectangles and triangles which have a designated area, -- their choice of shape. You can continue with the development to parallelograms, with which the students have already had some experience, by relating parallelograms again to rectangles and triangles. Students can measure outdoor areas around the school and calculate how many square meters. They can plan garden plots.

AREA:
From Counting Squares to Finding Formulas



First you learned what area means. Then you measured area by actually counting how many squares of a certain size it took to cover a surface.

Area of the rectangle is ______cm²



After you learned how to multiply, you saw an easier way to find the area of a rectangle. Instead of counting squares one at a time, you could find how many squares there were by ____________ length of the rectangle by its width.
(adding, multiplying)

Area = 35 mm x 10 mm = ______ mm²

Your centimetergrid paper is ruled into squares. The ruled rectangle is 25 cm by 20 cm. How many square centimeters?
______cm²

If a lawn measures 10 metres by 13 meters, what is the area of the lawn?
____
(Don't forget to write the units; m x m = m²)

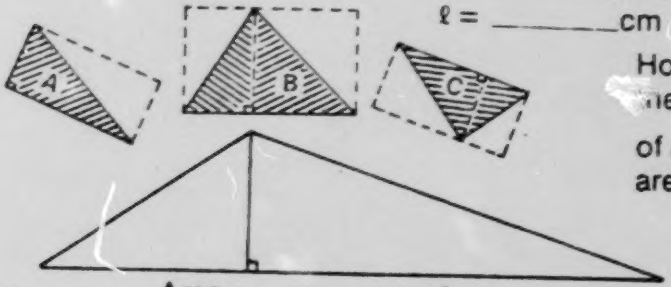
A formula is like a recipe; it tells what to do to get the results you want. For a rectangle: Area = length x width. Many times we shorten the writing by using only the first letters of the words in the formula. $A_{\square} = \ell \times w$

Measure the length and width. Then find the area.

$A = \ell \times w =$ ________ ______ (don't forget to write the proper units: cm x cm = cm²)

w = ______ cm

ℓ = ________cm



Area = ________cm²

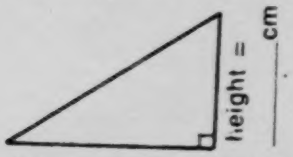
How about triangles? You learned that the area of a triangle is exactly ________ of a rectangle. So you could first find the area of the rectangle, then divide by ____.
(What part?)

If you have a formula, you can find the area of a triangle without having to draw a rectangle.

Call any side of the triangle a base (that will be like the length of the rectangle you could draw). Then if you draw a line segment to the base (call it the height) which would be exactly the same as the width of the rectangle, you can say:

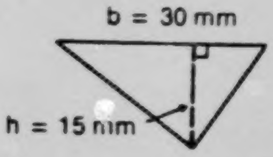
For a triangle: Area = base x height ÷ 2. Writing it the short way: $A_{\triangle} = \frac{b \times h}{2}$

Use the formula to find the area of each triangle:

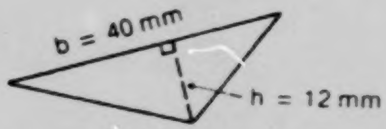


base = ________cm

Area = ________cm²



Area = ________mm²



Area = ______ ______
(don't forget: mm x mm = ____)

AREA

This section is a collection of ideas that can aid in the student's ability to recognize area in dm^2. I have started with ideas which are part of the students knowledge through previous instruction in metric length and cm^2, then have extended the observation.

General Objections:

1. To provide the opportunity for more manipulative experience with dm^2.

2. To provide experience working with dm^2 through cm^2.

3. To follow directional flow patterns as related to two dimentional area units.

Possible Activities:

A. Introduction to dm^2 (general)

1. Imagine an orange cuisenaire rod, with your fingers show the length of dm. (Check for accuracy)

2. Show dm^2 with your fingers. Length = dm
Width = dm

3. Think of a ½ gallon milk carton. The base = dm^2.

4. Look around the room to find articles that are approximately dm^2.

5. Estimate the area of: book, piece of paper, surface of chair, table, etc. in dm^2.

6. Have the students draw dm^2 on a blank piece of paper. Compare to a measured dm^2 from teacher.

B. Interest Ideas

1. Divide group into two parts. One group measure a piece of paper in cm^2 the other group measure an identical piece of paper in dm^2. List on the board the advantages and disadvantages of each measuring unit.

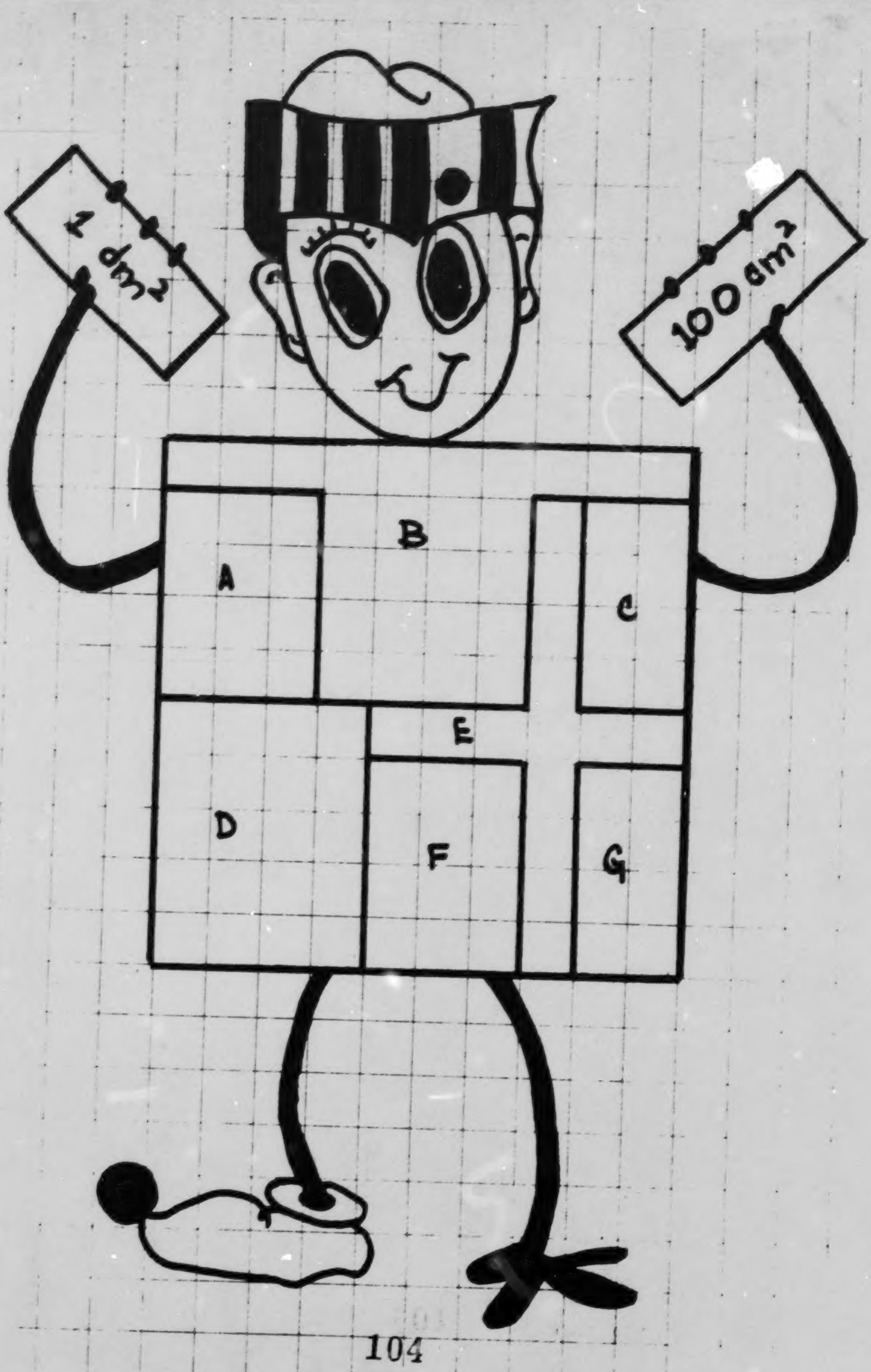
2. List the articles most likely to be measured in dm^2.

3. Students lie down on butcher paper. Trace their bodies, then find the area of their bodies in dm^2. (Have arms next to the body)

4. Students find the area of cm^2 'bodies' of the little sailor. Add each area. Find the total and put the 'bodies' together.
$100\ cm^2 = 1\ dm^2$. (Activity enclosed)

5. Working on a dm^2 marked in cm^2, follow directions of the teacher. (3 sets enclosed--must be scaled to dm^2.)

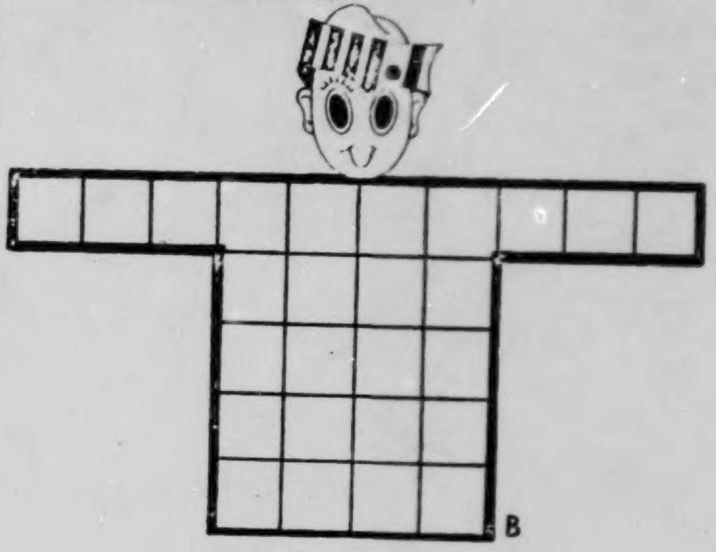
6. Dot to dot approach. Same idea as the grid in #5. Should be scaled to appropriate metric size - in cm^2 or dm^2 depending on size wanted.

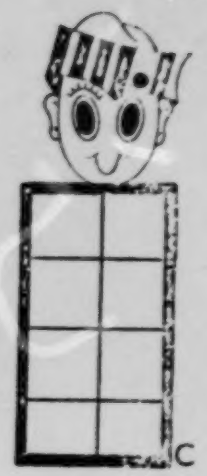

1 dm²
100 dm²
A
B
C
D
E
F
G

STUDENT ACTIVITY

AREA

Count the squares to determine the areas.
Record the results.



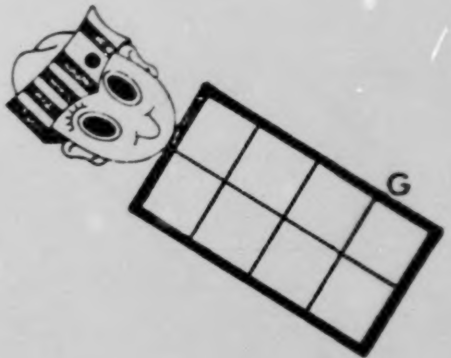


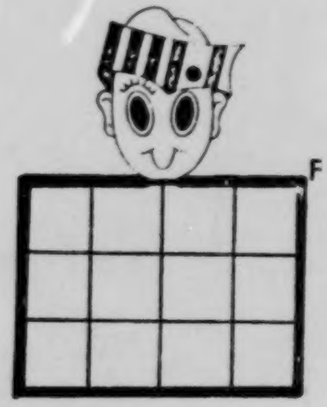
cm^2 ________

cm^2 ________

cm^2 ________

cm^2 ________

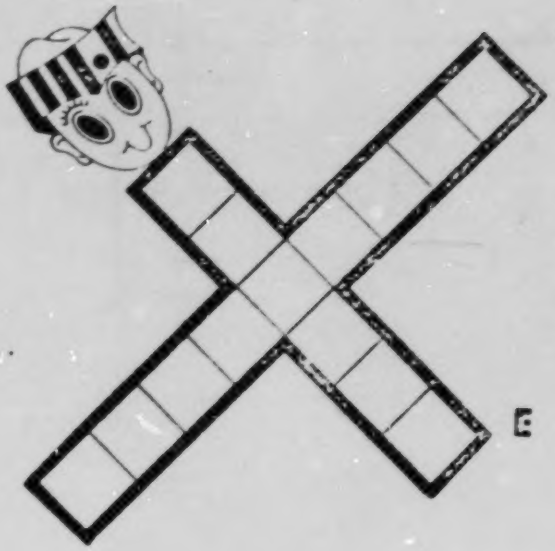




STUDENT ACTIVITY

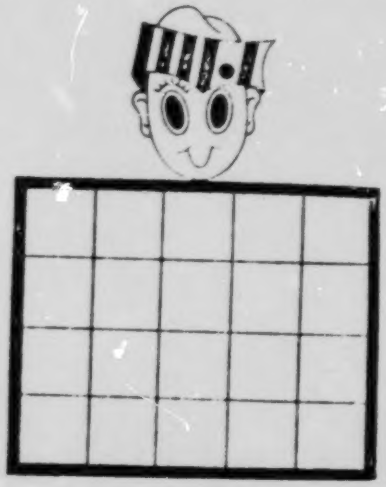
AREA

Count the squares to determine the areas.
Record the results.

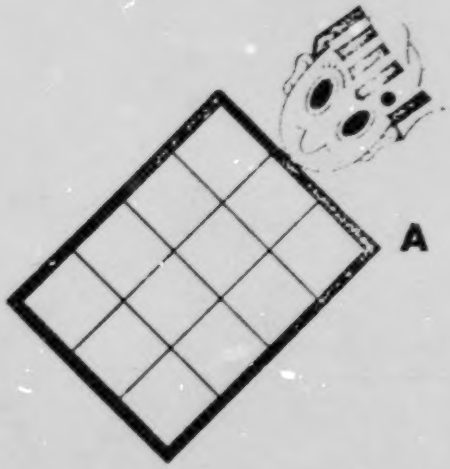


E

cm^2 ________



D

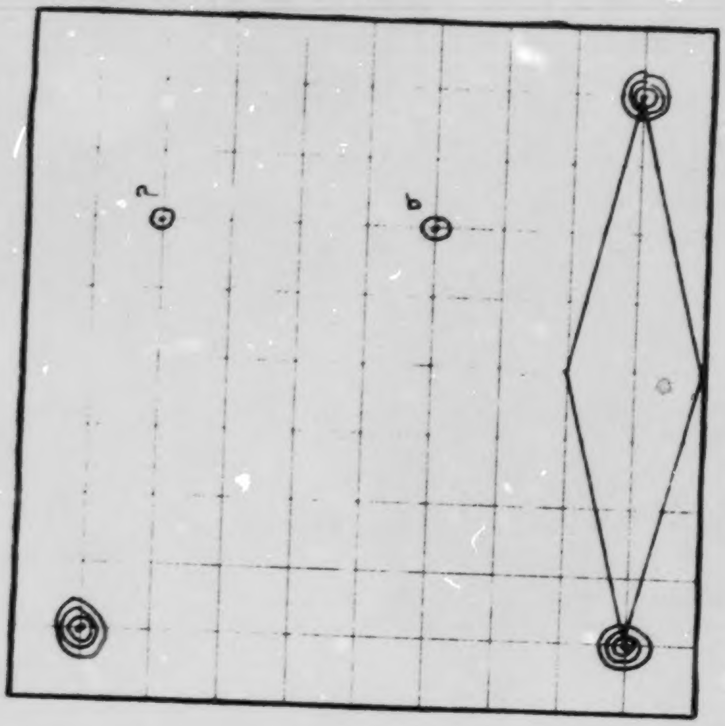


A

cm^2 ________

cm^2 ________

dm^2



HI

a

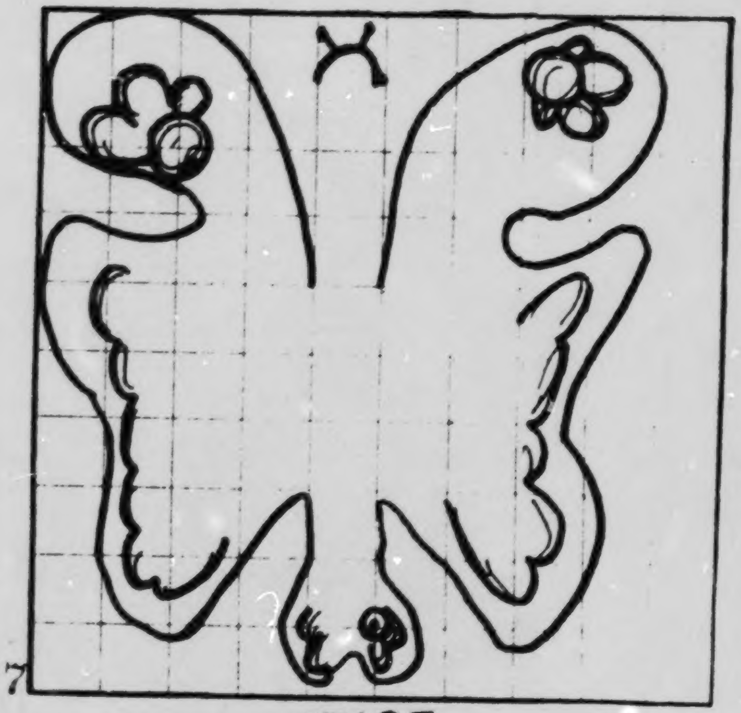
1. ↓ 5
2. → 1
3. ↑ 2
4. → 1
5. ↓ 2
6. → 1
7. ↑ 5
8. ← 1
9. ↓ 2
10. ← 1
11. ↑ 2
12. ← 1

b

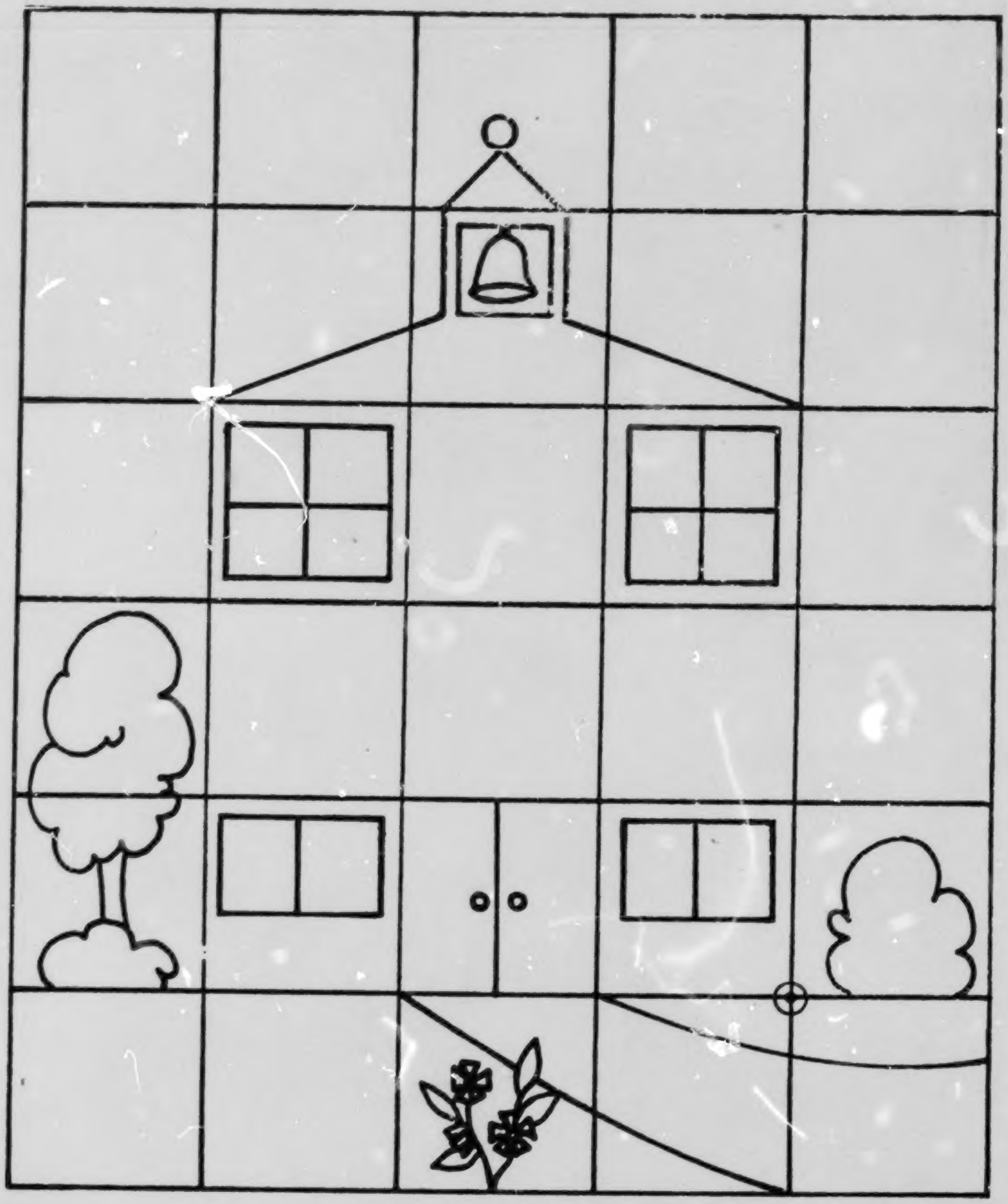
1. ↓ [illegible]
2. → 1
3. ↑ [illegible]
4. ← 1

BUTTERFLY

1. ↑ 2
2. → 3
3. ↑ 1
4. ← 2
5. ↑ 1
6. → 2
7. ↑ 1
8. ← 3
9. ↑ 2
10. ← 1
11. ↓ 2
12. ← 3
13. ↓ 1
14. → 2
15. ↓ 1
16. ← 2
17. ↓ 1
18. → 3
19. ↓ 2
20. → 1


START

AREAS ON THE GRID



1. ↑3 3. ↓3 5. ↑1 7. ↓1

2. ←3 4. →1 6. →1 8. →1

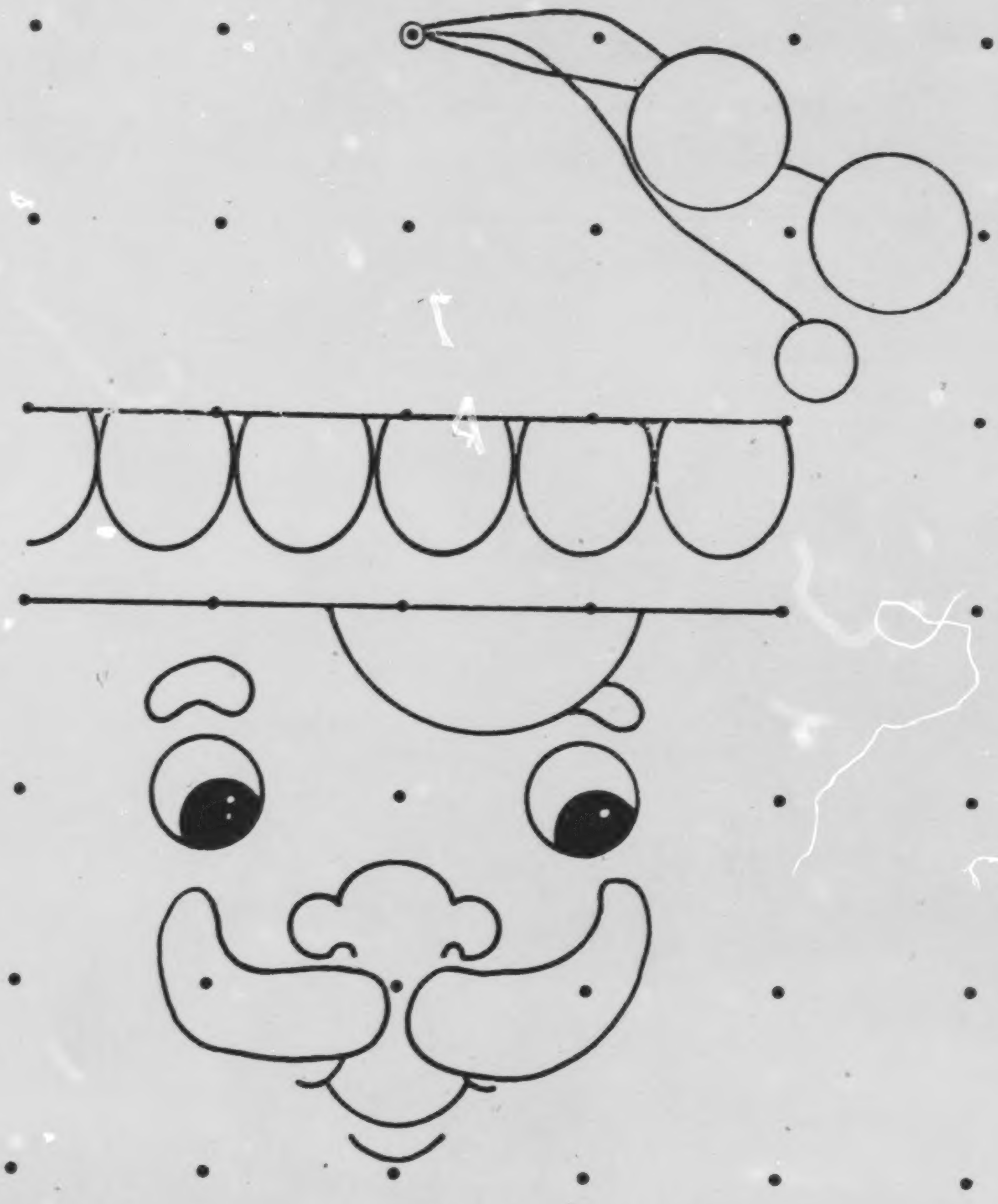
SHOULD BE SCALED TO METRIC UNITS

dm²

STUDENT ACTIVITY

ARROW AREAS

1) ↘ 2
2) ↓ 3
3) ↙ 1
4) ← 2
5) ↖ 1
6) ↑ 3
7) ↗ 2



109 DOTS SHOULD BE ARRANGED IN CM²

AREA: Meter

The following sheets deal with the measuring of area by using meters squared as the basis of measurement.

General Objectives:

1. The students will gain physical experience with the measurement of area by using the square meter.
2. Students will use manipulatives, representatives, and go to the algorithm of area by using square meters.
3. The student will count the number of decimeter squares, centimeter squares and the millimeter squares in a square meter.

Comments:

The square meter is a rather cumbersome object to use with children to perpetuate the understanding of area. Square meters should be used only as an introductory process for figuring and dealing with area.

The following activities are used to give the child a feeling for the square meter. They also may be used to show the physical relationship between square meters, square decimeters, square centimeters and square millimeters.

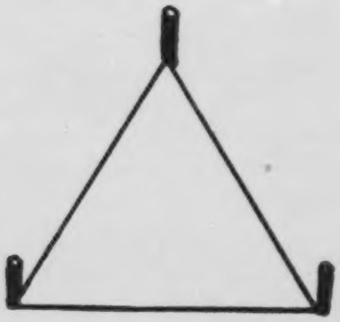
A. THE SQUARE METER (m^2)

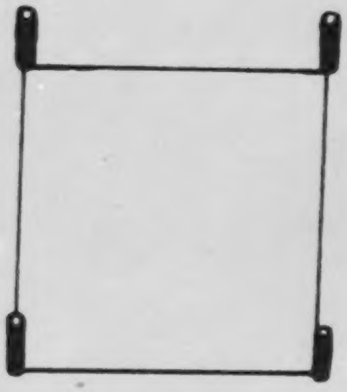
Objective:

Students will gain a physical experience dealing with the measurement of Area using the square meter.

Activity:

1. Using three stakes have student place out, by eye, a triangular piece of ground with three sides of equal length ten meters.
2. Check by using a meter stick. Comment on their accuracy and replace stakes to right size.
3. Using four stakes have students place out, by eye, a square with five meters on each side.
4. Check results by using meter stick, place sticks in right place.
5. Vary the above by using different lengths until the children get a feeling for the size of a meter.





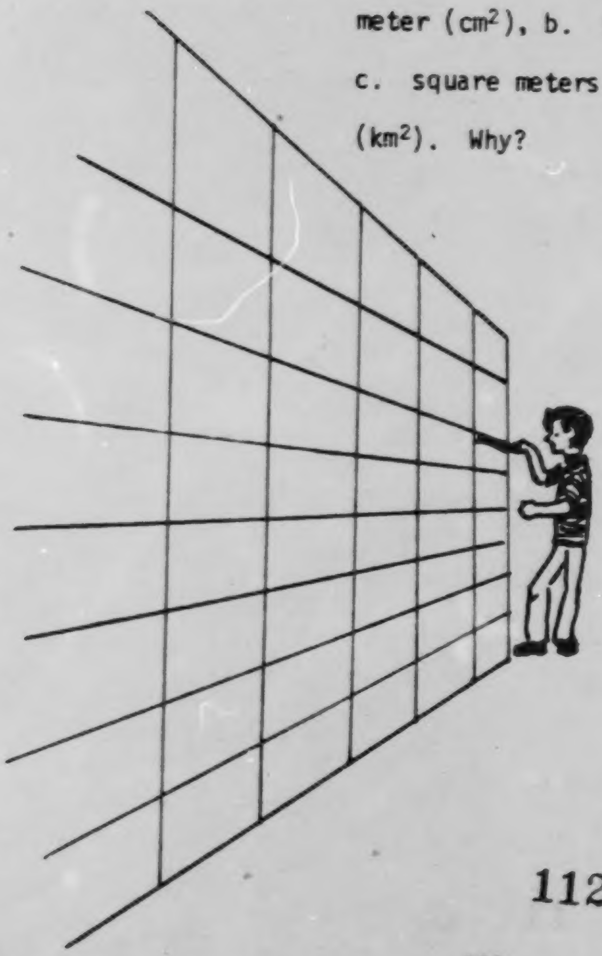
B. THE SQUARE METER (m^2)

Objective:

Students will by estimating and calculating determine the area of a brick wall.

Activity:

1. Have the children find a brick wall in your school and measure the area of one of the bricks.
2. Students will then estimate the height of the wall.
3. Students will be asked how high is the wall. Tell them to find the total area of the wall by using the area of the one brick.
4. Ask: What unit of measurement would you use?: a. square centimeter (cm^2), b. square decimeter (dm^2), c. square meters (m^2), or d. square kilometers (km^2). Why?



C. THE SQUARE METER (m^2)

FLOOR MEASURES

1. On the floor arrange 4 meter sticks to form a square. In one corner place a milk carton. Use this perception to determine:
   - (a) The number of milk cartons you could place in one row inside the square
   - (b) The number of rows
   - (c) The number of dm^2 in 1 m^2

2.

AREA	YOUR ESTIMATE (in m^2)	ACTUAL	ERROR
(a) Floor of room:	______ m^2	____ m^2	____
(b) End wall:	______ m^2	____ m^2	____
(c) Side wall:	______ m^2	____ m^2	____

The square centimeter (cm^2) may be used to determine the area of cards, footprints, tiles, birds' wings, leaves, photographs, newspaper advertisements; the surfaces of small blocks, boxes, tin cans, tennis balls, and footballs; the surface covered by many geometric and irregular shapes cut out of cardboard, cloth and paper; areas on maps in order to calculate the actual land area by scaling up.

Decimeter squares, if cut from tiles, cardboard, or plastic can be used as training aids. The squares could also be made to form a cubic decimeter or liter in the study of volume.

The square meter (m^2) will be useful in stating areas of floors, carpets, walls, paint coverage, wall paper, drapery material, plastic sheeting, driveways, lawns, patios; space requirements in homes, offices, tents, trailers, elevators, classrooms, cages in zoos, chicken coops, flower beds and greenhouses. Many goods such as carpets will be priced by the square meter. Lawn fertilizers will be spread in accordance with numbers of square meters.

D. THE SQUARE METER (m^2)

Objective:

Students will, by using manipulatives, see the relationship between square meters, square decimeters, square centimeters and square millimeters pertaining to area.

Activity:

1. Students will draw a square meter on a large piece of paper. Have the children use a book to make sure they get square edges.

2. Students may estimate the number of objects which they think will fit into their square.

3. Students will

    (a) (1) take one hundred square decimeters cut out of white paper.
        (2) decorate each square
        (3) glue onto large square meter
    (b) (1) take one hundred square decimeters made of colored paper
        (2) glue these squares onto square meter
    (c) (1) cut one hundred square meters using white paper
        (2) place onto square meter
        (3) draw and color one large picture
        (4) trade with a friend and put puzzle back together

4. Students may use the same process using square centimeters, and square millimeters. Because of the large number of squares needed you might choose to have them fill one part and then figure how many would be in the total meter.

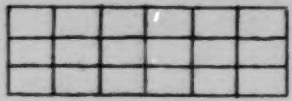
E. THE SQUARE METER (m^2) (To be used after lab #4)

Objective:

Students will discover the algorithm of area as length times the width.

Activity :

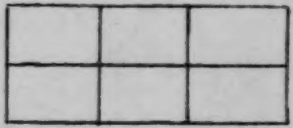
1. Draw picture on the board
2. Ask students how many squares are in the length, write it down
3. Ask students how many squares are in the width, write it down
4. Ask the students how many squares there are all together, write it down
5. Follow this process using various sized rectangles
6. Ask the students if they see a relationship between the number and the answer
7. Write the algorithm on the board



length = 7 square units

width = 3 square units

total = 27 square units



length = 3 square units

width = 3 square units

total = 9 square units

A = L x W

Comments:

This activity is not needed in the younger grades. As the children get older they will need to go into the more abstract forms of determining area.

Activities for the dam^2, hm^2, and km^2

1. The game of battleship may be used to reinforce the concept of any large square area. This game may also be adapted to be called treasure hunt, cowboys and indians, or may be adapted to any historical event.

2. The learner is given a square area to live in for one year. He can have anything that he desires to place within this area. All his personal needs will be met like food and water. This activity lends itself to a creative writing assignment. Graph paper may be used if desired. Concepts which might also be developed besides area would be time, values, form, material, etc. This activity is unlimited.

3. Using a large square area, could you develop your own life sustaining ecosystem. Graph paper may be used if the child hasn't been graphed to death already. The child would have to plan and use all available space.

4. You have a map of an enemy city of your choice and your team has to capture and hold a square area 24 hours and plan for the invasion force. You are to prioritize a list of tactical objectives for your team and the invasion force. You are to grid the city, plan your route of entry, route to your objectives, and exit route. You may adapt this to any historical battle and you may add other factors like logistics.

5. Use a map of your home city and grid the area. Which areas are more valuable, less valuable, more dense in population or less dense in population, etc. As a member of the city planning commission and also a real estate member, would this give you any ideas?

6. Could you plan your dream home or business using an square area.

7. What possible leisure activities could you plan for in a given squre area?

8. Using another piece of grid paper could you scale the class room and then the school grounds?

9. When the weather is nice take your class outside for a map reading class?

10. What is the cost to surface the football field with phoney grass? The highway from your town to the next? Gravel material vs asphalt?

CHAPTER THREE

THE METRIC MEASURE OF VOLUME

INTRODUCTION

Volume is a more advanced concept of measurement, consequently it requires a greater amount of preparation on the part of the student and teacher alike, before it can be introduced effectively in the class. The concepts of length and area must be thoroughly grasped by the student before the concept of volume can be attempted. It should be introduced in grade six.

The study of the "liter" should be preceded by the study of the cubic centimeter and the cubic decimeter. A cubic decimeter box should be built by the students and filled up with cubic centimeter blocks. The class should realize that it takes one thousand cubic centimeter blocks to fill up one cubic decimeter box. The decimeter box if filled up with liquid will contain exactly one liter, but if filled up with water at 4° C it will not only contain one liter but also weigh one kilogram. Every cubic centimeter of water at the same temperature will weigh one gram. It should also be made clear to the student that a liter is divided into one thousand milliliters.

Other activities that should follow are the building of the cubic meter and filling it up with decimeter cubes. A cubic meter holds one thousand of such boxes and if filled up with water at 4° C it will weigh exactly one "tonne" or one thousand killograms.

VOLUME WITH THE LITER, DECILITER, AND CENTILITER

These activities give the student experience with the liter, deciliter, and centiliter as units of volume measurement in metrics. They should be presented at the sixth grade level after experimentation with the liter alone. Although the deciliter and the centiliter are seldom used in everyday life, the concept of the relationships and the decimal representations are important in computational skills.

After activity I, introduce the term "deciliter." Tell the students that when a professional race car driver wants to find the exact mileage per gallon of his car, he puts one deciliter of fuel in it and drives until it stops.

Estimation activities using the deciliter should be included at this point to solidify the concept.

After activity II, the term "centiliter" should be introduced. Discuss who uses the centiliter. Show students syringes from a hospital.

VOLUME WITH THE LITER, DECILITER, AND CENTILITER

ACTIVITY I

Give each student, or group of students, one liter measure, one deciliter measure, and one centiliter measure without telling them the names of each. Use colored water if possible.

Tell students:

Fill the smallest measure with water to the top mark.

Then pour the water into the second size measure.

Repeat this until the second size measure is full to the top mark.

How many of the smallest measures did it take to fill the second size measure?

You should find that it took 10.

So the smallest measure is 1/10 of the second size measure.

But you know that the second size measure is 1/10 of a liter.

So the smallest measure is 1/10 of 1/10 of a liter.

1/10 of 1/10 is equivalent to 1/100

So the smallest measure is 1/100 of a liter.

We write 1/100 as a decimal like this: 0.01

Using the two smaller measures, pour these amounts into the liter measure. Empty the water after each problem.

1. 0.05 liter
2. 0.03 liter
3. 0.11 liter
4. 0.09 liter
5. 0.34 liter
6. 0.55 liter
7. 0.17 liter
8. 0.48 liter
9. 0.87 liter
10. 0.99 liter

Now measure out some amounts of your own.

VOLUME WITH THE LITER, DECILITER, AND CENTILITER

ACTIVITY I

Give each student, or group of students, one liter measure and one deciliter measure without telling them the names of either. Use colored water if possible.

Tell students:

Fill the smaller measure with water to the top mark.

Then pour the water into the larger measure.

Repeat this until the larger measure is filled to the top mark.

How many smaller measures did it take to fill the larger one?

You should find that it took 10.

The larger measure holds 1 liter, so the smaller measure holds 1/10 liter.

We write 1/10 as a decimal like this: 0.1

More or less than a liter?
Measure to find out.

1. 0.1 liter and 0.8 liter
2. 0.3 liter and 0.5 liter
3. 0.2 liter and 0.7 liter
4. 0.6 liter and 0.9 liter
5. 0.4 liter and 0.7 liter
6. 0.1 liter and 0.4 liter and 0.3 liter
7. 0.8 liter, 0.2 liter, and 0.4 liter
8. 0.5 liter, 0.1 liter, and 0.2 liter
9. 0.1 liter, 0.7 liter, and 0.3 liter
10. 0.4 liter, 0.2 liter, 0.1 liter, and 0.5 liter

VOLUME:

EXPERIMENT NO. 39

Apparatus: liter tube,
1 container 1 dm x 1 dm
1 dm water

1) Using dm box fill it with water.

2) Compare amount of water in box to a liter container.

3) Pour water from dl container to liter container.

4) How do the two containers compare?

EXPERIMENT NO. 40

1) If 10 deciliters (dl) is one liter (1) and 10 centiliters (cl) is one deciliter, how many centiliter are in one liter?

2) If 10 milliliters (ml) is one centiliter (cl), then how many milliliters are in one liter?

3) How many milliliters are in one liter?

EXPERIMENT NO. 41

1) Complete the following table

1. _____ milliliter (ml) = 1 centiliter (cl)
2. _____ cl = 1 deciliter(dl)
3. _____ dl = 1 liter (1)
4. _____ ml = 1 liter
5. _____ cl = 1 liter

VOLUME:

General Objectives: The purpose of these exercises is to introduce liquid measurements to students using the metric system. They are to use prior knowledge of the linear measurements to solve problems in liters, deciliters and centiliters.

Comments: Liquids are measured only in liters. Experiments comparing linear measurements and liquid measurements may not be valid. It does give the user some insight into the two measurements and helps them in solving new problems by using prior knowledge.

EXPERIMENT NO. 39

Apparatus: liter tube,
1 dl x 1 dl x 1 dl box

1) Using dl box fill it with water.
2) Ask students to compare amount of water the dl box contains to the amount in a liter container.
3) Pour water from dl container to liter container.
4) Ask students how the two containers compare.

EXPERIMENT NO. 40

1) If 10 deciliters (dl) is one liter (l) and 10 centiliters (cl) is one deciliter, how many centiliters are in one liter?
2) If 10 milliliters (ml) is one centiliter (cl), then how many milliliters are in one deciliter?
3) How many milliliters are in one liter?

EXPERIMENT NO. 41

1) Complete the following table

1. ______ Milliliter (ml) = 1 centiliter (cl)

2. ______ cl = 1 deciliter (dl)

3. ______ dl = 1 liter (l)

4. ______ ml = 1 liter

5. ______ cl = 1 liter

INTUITIVE ESTIMATION OF THE RELATIONSHIPS BETWEEN ENGLISH AND METRIC UNITS OF MEASUREMENT

Rationale: There are two ways to view the probable actions of the American people during the transition from the English system to the metric units of measurement.

1. People will try to forget the English system and begin using only the metric system.

2. People will use the English system as a frame of reference for learning the metric system (i.e. a meter is a little larger than a yard, a liter is a little larger than a yard, or a centimeter is about a third of an inch.)

I think school children will probably use the first method, because they will have access to exact units of metric measurement (i.e. a meter stick, not a meter/yardstick combination, an object weighing exactly 1 km or exactly 1 gram, or containers holding exactly 1 liter.) Because the average adult will not have access to these materials, I think he will use the second method. We all need some frame of reference for units of measurement. For example, if the average American is told that a person weighs 7 stone, we have no idea what the person weighs. We might reason that a rock is larger than a stone, and a stone is larger than a gravel, therefore a rock must weigh about a ton, a stone must weigh about a pound and then obviously, a gravel is about an ounce. Therefore, we would conclude that a person weighing 7 stone must be a baby. We will need some frame of reference for the metric system so that we can gradually assimilate the system and discover relationships of units of measurement within the system.

It also seems apparent that the schools will have to teach the parents as well as the students during the conversion from one system to the other.

Based on the above rationale, I have tried to provide activities that will show general relationships between the metric and English units of volume. The activities will give the student an intuitive understanding of the relationships and, hopefully, the students will be able to pass that information on to their parents.

Background information for teachers:

1.0 liter = 1000 ml
32 oz = 1 quart = .95 liter = 950 ml
16 oz = 1 pint = .47 liter = 470 ml
8 oz = 1 cup = .24 liter = 240 ml
1 oz = .03 liter = 30 ml

Concept - Students should understand approximate relationships between metric and English units of volume.

Activities - These activities were designed for use in the primary grades but could be used for introduction to metric units of volume with older students also.

1. Use jars commonly found around the house (catsup bottles, mayonnaise jars, milk cartons etc.) as well as metric containers, while teaching concepts of more than or less than.

2. Using above materials, compare amounts by pouring back and forth.

3. Use standard units of measurement to find out how many it takes to fill a container.

4. Using one container as a unit, record how many it takes to fill another container.

5. Following #4, label containers with unit lines i.e. ½ cans, 1 can, etc.

6. Estimate volumes of new containers, record estimates and verify.

Subject: Volume and Capacity with a Lot of Estimation

General Objectives:

1. To give students experience in estimating capacity and volume of containers of various shapes and sizes.

2. To continue giving students experience in measurement and estimation of milliliters and liters with liquids.

Comments:

This activity may be used in a small group situation or individually at a learning center. The containers should vary greatly in thickness, shape, and size. Your own situation will determine the number of containers to be used but it is recommended that you use at least five containers and no more than ten. It is a good idea to not only have fairly unusual containers in your collection but also some common, everyday containers such as pop bottles, paper cups and jars.

Materials:

Graduated metric cylinders; 10 ml, 25 ml, 50 ml, 100 ml, 250 ml, 500 ml, and 1000 ml or 1 liter.

Containers of various shapes and sizes

Water

Paper and pencils

Procedure:

1. Have students arrange containers in a row from least to greatest capacity.

a. Be sure to inform students how full you intend to fill the containers.

b. Allow students to handle and explore all the objects.

2. Let students compare containers to all the graduated cylinders.

3. After students place the containers in estimated order from least to greatest capacity, ask students to estimate, to the nearest ml, the capacity of each container.

4. Fill containers to the indicated level and measure to the nearest ml.

a. Let students discover the most efficient way to measure liquid.

i.e. Pour liquid from graduated cylinder to container and add or subtract difference OR fill container to indicated level and pour into a large enough graduated cylinder to hold all the liquid--this in itself is another estimation exercise.

5. Students rearrange containers if their estimation was inaccurate.

VOLUME - WATER DISPLACEMENT

A. Objectives: To give 100% of the students a method of measuring irregular-shaped objects for volume with 95 to 100% accuracy.

B. Materials

1. Container marked in (ml) total needed 1,000 (ml)
2. Objects in irregular shapes to be measured.
    - a. rocks
    - b. eggs
    - c. persons hand
    - d. bottles
    - e. pieces of wood

C. Procedure

1. What is volume?
    - a. Space occupied as measured in cubic units.
2. How do we find volume?
    - a. I would give an answer that would fit the age group.

      Anywhere from : $V = H \times L \times W$ to these formulas,

        1. Cube $V = A^3$
        2. Rectangular Prism $V = A \times B \times C$
        3. Pyramid $V = \frac{ah}{3}$ a = area of base
           h = height
        4. Water Displacement
           V = water displaced
           when object is submerged
3. What is water displacement?
    - a. The volume or weight of a fluid displaced by a floating body of equal weight.

4. Experiments:
    a. Have students experiment with volume by measuring the objects and comparing one object's volume to another object's volume.

B. Experiment #2 - Use this experiment to distinguish the measurement of weight compared to volume of the object, by using an object that will float.

Using a piece of wood or any other object that will float.

Place the object in the water and let it float. Measure the water displacement, then submerge the same object and remeasure. Explain the difference as follows: If the object floats and is not submerged you are only measuring the objects weight. Where as if the object is submerged you are measuring it's volume.

C. Experiment #3 - This experiment distinguishes between mass and volume.
    a. two objects
        1. a heavy rock
        2. an egg
    b. Make the two objects similar in size, but different in weight. Have the students experiment with the displacement then talk about what weight has to do with finding volume.

D. Evaluation

Have the students either in groups or as individuals find the volume of three to five irregular objects that the teacher selects.

E. Conclusion

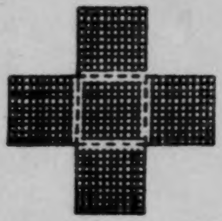
The purpose of the lesson is to provide the students with a method of measuring the volume of irregular objects.

MAKE A LITER CUBE

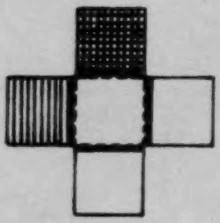
Pete and Ann wanted to make open cubes like the liter cube in the kit. They looked carefully at the cube to figure out how to make theirs.

Ann said, "We need something stiffer than paper to make a good cube that big." Pete agreed with her, but he added, "It would be nice to have a paper pattern we could use to make the cube. We could make the pattern from the centimeter grid paper, and glue or tape it on cardboard from a box--like a shoe box."

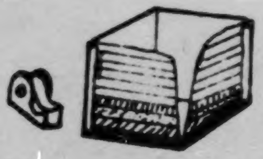
They decided to use centimeter grid paper to make it easier to get the pattern size just right. Each edge of the cube should be ______ cm. For an open cube they needed __________ (how many) squares, each measuring ______ cm by ______ cm. What is the area of the base? (Think about or look at a square grid 10 cm by 10 cm.) __________ cm^2.



You can make a cube that will hold 1 liter, the same way Pete and Ann did. First cut out 5 squares, each 10 cm by 10 cm, for a pattern. If your cardboard is large enough, you can put your squares on it like the picture. If it isn't big enough (and most boxes aren't), first cut out squares, then tape them together to look like the picture.



If you want to color the sides of your cube to show each centimeter of height, do it like this: Color each 1 cm by 10 cm strip closest to the center square the same color (say red). Then do the next strip on each side square blue. Keep on going until you have colored all __________ (how many) cm of height.



Next fold the sides up along the dashed lines (where they join the center square which will be the base of your cube) and tape the edges together carefully.

You now have a cube 10 cm by 10 cm. Figure out how many cubic centimeters it holds. The area of the base is ______ cm^2. If you filled your box with centimeter cubes, each layer would need 100 cubes. How many layers would there be? (How many centimeters high?) ______________

Altogether you would have 10 layers of 100 cubes each. That makes __________ (how many) cubes, so the volume is __________ cm^3.

If you want to use your cube for measuring volume, put a strong plastic bag inside it.

MAKE A LITER CUBE

This sheet gives instructions for the student to make an open cube like the one in the kit, which will hold a liter.

General Objectives:

1. Give the student more experience in following pattern directions to make a volume container.

2. Provide further practice in considering volume as stacking layers of cubes, to develop understanding of the eventual formula.

3. Provide the student with his own usable model, marked in tenths, so he can use it for measuring.

Comments:

If the student uses any reasonable cardboard (shoe box or equivalent discard will serve the purpose at no cost) his model will be sturdy enough, when outside edges are taped and the inside is lined with a plastic food bag (large enough to drape over the entire box to protect it from accidental spills) to fill with water to any desired height. The student can also experiment with the rods from the kit. Ten rods would make one layer, -- but the fact that it is difficult to put them next to each other without some intervening space may make it impossible actually to fit them inside the box. This can be explained, pointing out the difference between the theoretical statement and an actual physical experiment, which differs somewhat from the "ideal" model.

Once the students have made decimeter cubes, it becomes practical to consider the cubic meter. If you have already laid out a square meter in a corner of the room, on the floor, you can now model a cubic meter by holding a meter stick on the fourth vertex of the square and putting a large sheet of cardboard or construction paper (again, 1 square meter) on the top. Students can get inside the cube (like the picture in the volume program) to gain some experience with size. Also the students can now theorize on how many of their liter cubes it would take to fill the meter cube. Then how many of the small centimeter cubes would it take? This kind of discussion can motivate models of place value and large numbers.-- Do not expect any but the most mature students to do any calculations of this type; it is a lead-in discussion topic for your use in giving a physical model for numbers like a million.

THE CUBIC DECIMETER (dm^3)

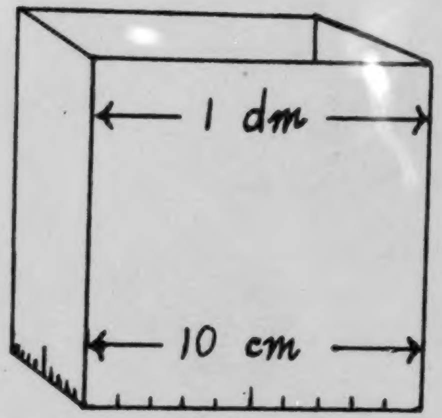
THE LITER (L)

THE CUBIC CENTIMETER (cm^3)

THE MILLILITER (ml)

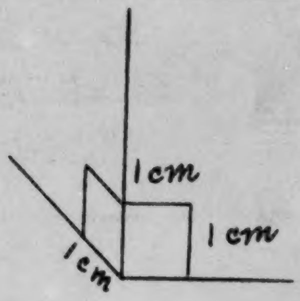
Volume and Capacity

1. (a) Using the sheet of cardboard supplied, construct an open rectangular box with each edge 1 dm long. Use plastic tape to secure the edges.
   (b) Compare your container to the milk carton.
   (c) Select one bottom corner and mark in centimeter scales along each dimension.
   (d) Label 3 adjacent edges as 1 dm.



(Scale drawing)

Exercise - Volume and Capacity (continued)



2. (a) Select another bottom corner and draw in the lines to show the size of 1 cm^3

   (b) How many centimeter cubes would fit along one row of the bottom? ______

   (c) How many such rows would fit into the bottom? ______

   (d) How many cm^3 would there be in this bottom layer? ______

   (e) How many layers would fit into the whole box? ______

   (f) How many centimeter cubes would fit into the whole box? ______

______ cm^3 = $\underline{\ 1\ }$ dm^3

3. (a) The capacity of this box is 1 liter (1 L). What is the capacity of 1 dm^3? ______

4.

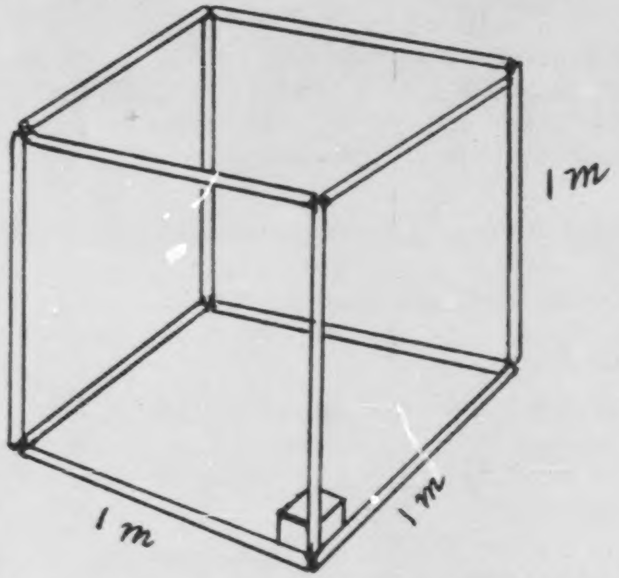
CONTAINER	YOUR ESTIMATE OF CAPACITY IN ml	ACTUAL CAPACITY BY CALCULATION	ERROR
Shopping bag:	______	______	______

THE CUBIC METER (m^3)

EXERCISE - Volume and Capacity

(Packing cases and tanks)

1. (a) Please contribute 12 "newspaper" meter measures (from exercise 2D) and your assistance to construct the skeleton of a meter cube, in the corner of the room.



(b) Place a decimeter cube (use your liter containers from exercise 2E) within the meter cube in one corner.

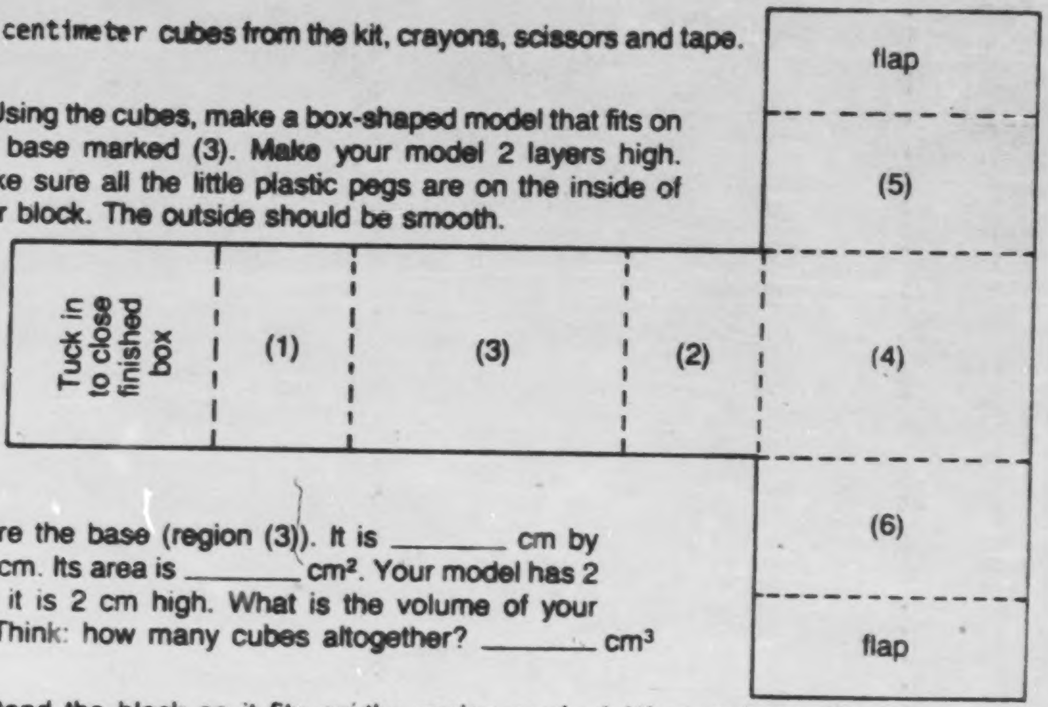
How many decimeter cubes (liters) would fit into one row along the bottom of the meter cube? ______

CUBES, BLOCKS, AND A BOX:
More Volume Experiments

You need centimeter cubes from the kit, crayons, scissors and tape.

Do

1. Using the cubes, make a box-shaped model that fits on the base marked (3). Make your model 2 layers high. Make sure all the little plastic pegs are on the inside of your block. The outside should be smooth.



2. Measure the base (region (3)). It is ________ cm by ________ cm. Its area is ________ cm². Your model has 2 layers so it is 2 cm high. What is the volume of your model? (Think: how many cubes altogether? ________ cm³

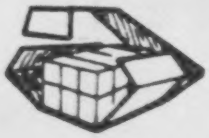
3. Now stand the block so it fits on the region marked (1) as a base. The base measures ________ cm by ________ cm, and its area is ________ cm². How many centimeter high is your model now? (How many layers are there?) ________________ Each layer has as many cubes as there are squares in the base. Altogether there are 4 layers. So the volume is 24 cm³ (because 6 + 6 + 6 + 6 = 24).

4. Now turn your model so it fits on the base marked (5). What is the area of this base? ________ cm². How many cm high now? ________ cm. Does the volume change because you turned the model? ________________ This time the 24 cm³ comes from ________ layers of ________ cubes each.

5. How many corners does your model have? ________ Choose any one of the 8 corners. How many edges meet at that corner? ________ We say the model is 3 dimensional (say DI-MEN-SHUN-AL). Measure the 3 edges from any corner: ________ cm, ________ cm, and ________ cm. The 3 dimensions will always be 2 cm by 3 cm by 4 cm, but which ones you might call length, width and height will be different, depending on which base is at the bottom.

6. Now you can make a box the same size as your plastic model. First color the six bases on the pattern. If the area of a base is 6 cm², color it blue. If the area is 8 cm², color it red. If the area is 12 cm², color it green.

7. Cut out the pattern on the solid line. Fold on all the dashed lines so the dashes will be on the outside. Turn your pattern over so the colored part is facing down. Put your plastic block on top of region (4); then fold around the block so the two flaps just meet at the top.



8. Tape the two flaps together where they join. Now fold along the other dashed lines around the block. Slide the block out, and tape or glue other edges if you want to. Your box is finished!

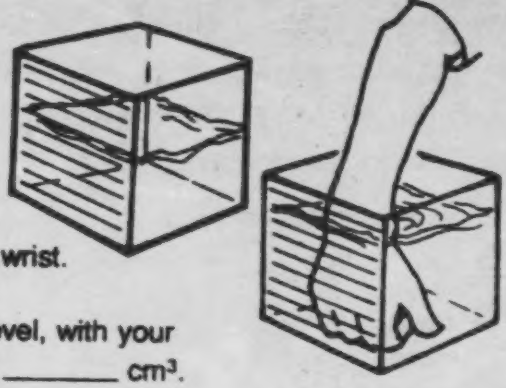
DISPLACEMENT:

How You Can Find the Volume of a Rock or an Egg or a Lump of Clay or Your Hand

Do you remember how you measured area indirectly? You found areas of odd shapes by measuring their mass, when you had no easy way to measure the area directly.

You can use the same idea of indirect measurement to find volume. Think about what happens to the water level in the bathtub when you get in the tub. Here are some experiments you can do to find the volume of objects that will not be changed by getting wet. (Don't try it with salt!) Start by finding the volume of your hand. You need the liter cube and water

1. Fill the cube with water up to the 6th line from the bottom (600 cm^3).



2. Put your hand in, up to the wrist.

3. Read the new water level, with your hand in place. It is about ________ cm^3.

4. The volume of your hand must be the same as the volume of the water it displaced (displaced means pushed out of place).

5. Then the volume of your hand must be new level − old level,
   ________ cm^3 − 600 cm^3 = ________ cm^3.

6. What problem would you have if you tried to use this method to find the volume of something made of wood, like the rods in the kit? ______________________________
____

Now you can do some more experiments to find volume of objects that sink in water, by measuring displacement of water. Get a 250 ml or 400 ml beaker, some clay, some plastic masses from the kit, and some other object that you choose.

On the top line of the chart, state what object you are measuring. For each object, read the volume of water in your beaker without the object and fill in the third line of the chart. Then read the volume with the added object and fill in the second line. The difference will be the volume of water displaced = volume of the object.

1. Object measured:	________ grams of plastic	lump of clay	
2. Water level with object:	cm^3	cm^3	cm^3
3. Water level without object:	cm^3	cm^3	cm^3
4. Displacement = volume of object:	cm^3	cm^3	cm^3

DENSITY:

Mass Compared to Volume

You learned that the Celsius temperature scale is based on the freezing and boiling points of _______________ (water, air). Water is very important to life on Earth and very plentiful. Because water is so basic (sometimes Earth is called "the water planet") many of our measurements are based on water.

Mass is an example. The kilogram, a base unit for mass, is the mass of 1 liter(1dm³) of pure water (at sea level, at 4°C). 1 kilogram = ___________ (how many) grams, and 1 liter = ______ ml, so 1 gram is the mass of _____ ml of pure water.

An object will float in water if its mass is less than the mass of the same volume of water. We say its density is less than the density of _______________ (air, water).

An object will sink if its density is _______________ (less, more) than the density of the liquid you put it in.

Try an experiment to see what happens to the density when you dissolve salt in water.

You need:

- balance scale
- masses from the kit
- 100 ml measuring beaker
- water
- salt

Do:

1. First weigh your beaker, empty. Its mass is ________ g. Fill in the second line of the chart.

2. Now put 95 ml of water in the beaker. Add about 15 ml (1 tablespoon) of salt, and stir until the salt is dissolved. Read the volume now. It is probably about 100 ml. If it is less than 100 ml, add water, a few drops at a time, until you have 100 ml. If the volume is more than 100 ml, soak up some water by dipping a small piece of paper towel in the liquid.

3. When you have 100 ml of solution, weigh it again, being careful not to spill any water. The mass is _______ g. Fill in the top line of the chart.

mass of beaker with 100 ml of salt water	_______ g
mass of empty beaker	_______ g
difference = mass of 100 ml of salt water	_______ g

Fresh water has a mass of 1 g per ml, or ________ g for 100 ml.

The salt water has a mass of ________ g for 100 ml.

The density of the salt water is _____________ (more, less) than the density of fresh water.

In your last experiment the plastic masses sank in plain water but floated in salt water. What can you say about the density of that plastic? ____________________
____

You can measure the density of the plastic if you want to. Use your 250 ml beaker. Put 150 ml of water in it. Then add enough plastic masses to raise the water level to 250 ml. Make sure that there are no air bubbles, and that all the masses are under water. The volume of the plastic equals its displacement (how much water it displaced). The displacement is 250 ml − 150 ml = ________ ml. Then empty the beaker and count how many grams of plastic masses. The total should be between the mass of 100 ml of plain water (100 g) and the mass of 100 ml of salt water.

CHAPTER FOUR

INTRODUCTION TO THE METRIC MEASURE OF MASS AND WEIGHT

Mass is anything that occupies space; to occupy space it must be composed of matter, and matter may be in a gaseous, liquid or solid form.

Weight is a gravitational pull exerted by the earth on the mass. The larger the mass, or the amount of matter, the greater will be the pull. Mass on the Moon will weigh six times less than on the Earth because the gravitational pull by the Moon will be six times less on the mass.

Gravitational pull is a force and as such it can be measured. In the metric system the measuring is done in grams, kilograms and tonnes (mainly). A kilogram is a unit of measure made up of one thousand grams. It is also equal to the weight of one cubic decimeter of water at 4°C, at sea level. At higher altitudes the kilogram will weigh less because the pull of the Earth will be smaller, being farther away from the center of the Earth.

Mass and weight are not easily understood by children and should not be attempted before the students have been introduced and fully understand the concepts of length, area and volume.

The activities in this chapter are interesting and easy to follow and the teacher should make full use of them.

MASS: Comparison

General Objectives:

1. Give the student a chance to experiment with different sizes of objects and their weight.

2. Students should conclude that size or shape does not determine whether an object is heavy or light.

Activities:

1. Have students weigh objects that look similar and are the same size but of different density. Students will compare the weights and suggest reasons for the difference of weight.

2. Compare objects of different size and weight and arrange them in order of heavy to light.

3. By lifting and estimating, compare two objects to see which has the greater mass. Next weigh the objects. Possible pairs could include: a pint of milk and a pint of water, a slice of cheese and a slice of bread, a bag of popcorn and a bag of marbles, and a volleyball and a basketball.

Equipment:

1. Materials suggested in the activities.
2. A balance scale or spring scale.
3. Metric weights for balance scale (if used).

INTRODUCTION TO MASS

The mass of an object is constant. The weight of an object is variable. After an object is weighed and its mass is known, it is most often said to WEIGH an amount expressed in units of MASS. There are elements of inaccuracy in doing so, because the weight of an object is often determined as the amount of Earth's gravitational pull or force. Such measurement will result in different weights at different places on the Earth's surface, e.g., sea level and mountain tops. The object's mass is always the same.

The reason for this is that gravitational pull between two objects (in this case the Earth and the object) varies. The closer they are, the stronger they attract or pull on each other. An object at sea level is closer to the center of the Earth than it is on a mountain top. At which point will its weight be greater? Will the mass of the object be the same?

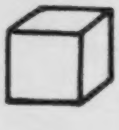
An astronaut, his space ship, food and helmet have almost no weight at all, far out in space. There is almost no gravitational pull toward Earth (or toward other planets or stars) so they weigh almost nothing. They have the same mass no matter where they are.

On Earth there is a man-made standard of MASS. It provides for very accurate measurement by the familiar method of "weighing" an object. The weighing is a comparison of the pull of Earth's gravity on the object AND on the standard known mass at the same place and time. This can easily be done by using a balance beam scale. The gravitational pull of Earth is the same on both the unknown object and on the known standard, such as gram or kilogram weights.

Many interesting experiments are possible using the balance beam scale, a construction project.

The gram and kilogram are useful units for measuring the mass of objects. One cubic centimeter of water has a mass of one gram at 3.6° C at sea level.

One cubic centimeter displaces one milliliter of water. 1000 ml (one liter) of water at 3.6° C at sea level has a mass of one kilogram.



1 cm^3 filled with water weighs 1 g

dm^3 = 1000 cm^3 filled with water weighs 1000 g = 1 kg

MASSING YOUR FRIENDS !!

Kilogram card 2

Work with several friends to do this project. You will need a kilogram mass, a metric bathroom scale, the bo of centimeter strips, a piece of chart paper, your notebook and pencils.

STEPS TO FOLLOW:

1. Copy the chart below in your notebook.

OUR MASSES IN KILOGRAMS		
NAMES	ESTIMATED MASS	ACTUAL MASS

2. Pick up the kilogram mass and pass it around so that everyone in your group gets a chance to feel how heavy it is.

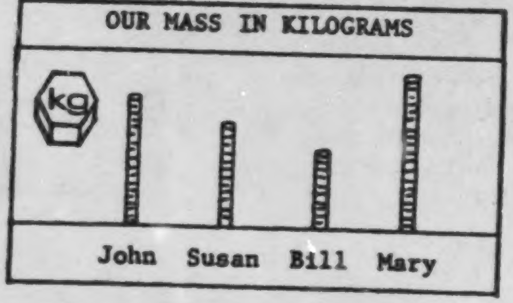
3. Each member in the group estimates their own mass in kilograms. Record your estimate on your chart.

4. Each member of the group estimates the mass of each other group member and records the names and estimates on their own chart.

5. Use the bathroom scale to find the actual mass of each group member. Record the results on your charts.

6. Look at your estimates and actual measurements. Were they close?

7. Use the centimeter strips and piece of chart paper to make a bar graph to show the actual mass of all the members in the group. Let each square centimeter on the strip represent one kilogram. If, for example, your mass is 23 kilograms, you are going to have to make a strip 23 centimeter long to represent your mass. You may have to glue strips together or cut part of a strip away to make a strip that exactly pictures your mass. Paste the strips on the chart paper, as shown below, and display it in your classroom.



Kilogram card 1

LEARNING ABOUT
KILOGRAMS

Work with a partner. Get the box which has a balance and a big heavy mass in it. This mass is called a kilogram.
You will also need a notebook and your pencil.

DIRECTIONS: Read carefully and write your answers in your mathematics book.

1) Pick up the kilogram mass and hold it in your hand to feel how heavy it is.

2) Now search around the classroom and find as many things as you can that have a mass of about one kilogram. Use your body balance to help you.

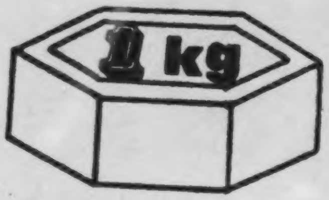
3) Take the balance out of the box and place the kilogram on one side of the balance. Now place each of the objects you have collected on the other side of the balance, one at a time. You will then know if each of your objects has a mass of:
   - less than one kilogram,
   - about one kilogram, or
   - more than one kilogram.

4) Make a chart in your notebook like the one below and record your findings.

KILOGRAM CHART : kg

Objects I have found that have a mass of less than one kilogram	Objects I have found that have a mass almost the same as one kilogram	Objects I have found that have a mass more than one kilogram

5) If you found the mass of your pet dog to be six kilograms, you could write six kilograms this way: 6 kg



Write these using the kilogram symbol:

a) Heavy book with a mass of two kilograms = ________

b) Table with a mass of seven kilograms = ________

c) Filmstrip projector with a mass of three kilograms = ________

MEASURING WITH GRAMS

weighing a gram !!!

The activities below can be used to introduce your students to the gram masses and give them experience in measuring with grams. Following these are activities which give children practice in measuring with kilograms and grams together.

1. Have children bring in labels from home which show materials measured in grams. Children can display these on a chart or bulletin board.

2. The teacher locates a box of paper clips which contains clips which have a mass of 1 gram each, or obtains some centicubes (each centicube has a mass of 1 gram). Have the students use the grams and the balance to find the mass of several tiny objects. eg. Thumbtack, feather.

3. Give children a set of gram masses and have them arrange them in order from the lightest to the heaviest. They could then draw pictures of the masses and print the number of grams under each picture. They could also use the set to figure out how many grams there are in one kilogram.

4. As with kilograms, children can use plasticine, sand, or other materials to make sets of gram masses to use with any of the gram activities that follow.

5. Let children use the commercial masses and their own masses to find the mass of a variety of classroom objects which they select.

> NOTE: Make sure children get into the habit of ESTIMATING before MEASURING, as well as RECORDING all estimates and measurements in their notebooks.

6. Children can be sent out to find the mass of other school objects. For example, they can go to the library to do the following:
   a) Search the library to find the heaviest and lightest books.
   b) Find the mass of a set of encyclopedia.
   c) Find the mass of the librarian.

7. Fill paper cups with materials such as: cereal, peas, rice, sand and water. Have them estimate how many grams of material each cup holds. Supply them with a balance and let them use their weights to check their estimates. Estimates and actual measurements can be charted.

8. Balancing masses: See the sample project card or activity sheet on the next page.

MEASURE MASS

General Objectives:

1. Introduce mass, a new kind of measurement, one that will provide good place value practice and be interesting, novel, and simple for the students to do.
2. Introduce a new prefix, "kilo" and give practice in its meaning.
3. Provide experience with two different kinds of tools used to measure mass, the balance scale and the spring scale, which work on different principles.

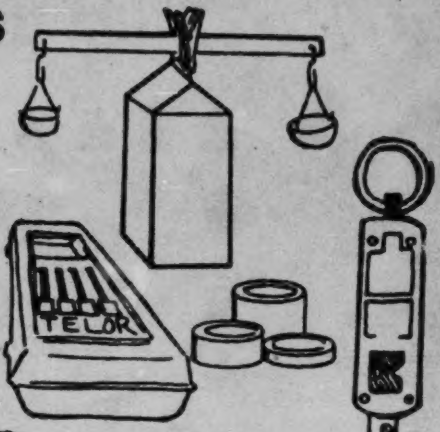
Comments:

The activities in this program are appropriate for all your students. For the more sophisticated or mature students, the analogy between the scale in balance and an equation can be pointed out. The program has the students use the balance and the spring scale in the kit to do weighing operations, and points out the principle on which each operates, in very simple analogies which refer to familiar objects like the play ground seesaw.

You will notice that the program uses the correct terminology, "mass" throughout. The simplest way to have the student learn correct terminology is to use it regularly. A later sheet in the mass section explains the distinction between mass and weight (M-6, N IS FOR NEWTON). At this point, however, it would be advisable not to raise the issue at all. If asked, you can explain that when people talk about weight, they usually really mean mass, and the common term is simply rather imprecise, like "His half is bigger than my half."

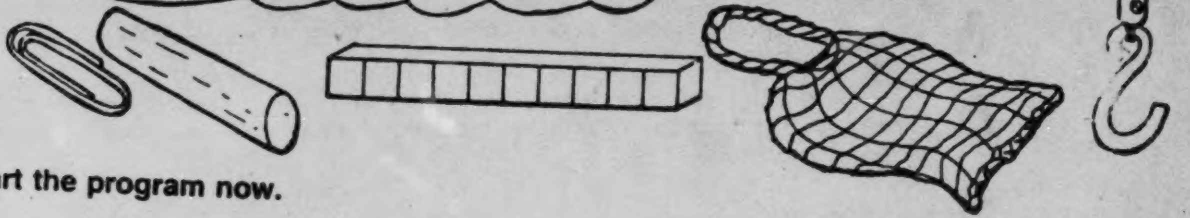
You might explain to students that when people talk about a "kilo", they mean a kilogram. The short form is used quite frequently in conversation.

MEASURE MASS



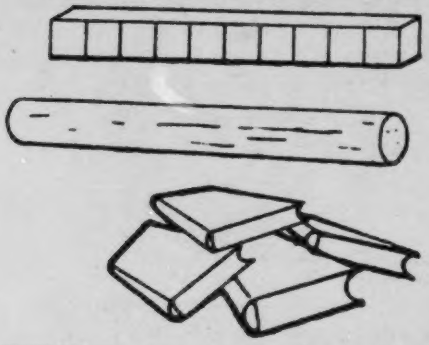
You need the Telor program on Mass, the balance scale to use for weighing, and the set of stacking masses from the kit,—to start learning about mass

Later you will need a paper clip, a wooden rod, a new piece of chalk, 10 of the small cubes from the kit, the spring scale, the mesh bag,–and some other things



Start the program now.

Use the balance scale to find:



1. Mass of the rod = ________ g
2. Mass of the chalk = ________ g
3. g stands for ________

Now use the spring scale and the mesh bag to find

4. Mass of 4 books =________ kg
5. Kg stands for ______________
6. 1 kg = ________ g

Now look around the room for some things you could weigh with the balance scale. Try to guess ("estimate") each mass first. Then weigh the object and see how close your estimate was.

	Estimated about	Weighed about
1. A pencil	______ g	______ g
2. A chalkboard eraser	______ g	______ g
3. The spring scale in the kit	______ g	______ g
You choose 3 more things and fill them in below:		
4. ______________	______ g	______ g
5. ______________	______ g	______ g
6. ______________	______ g	______ g

Now do the same thing for heavier objects, using the spring scale:

	Estimated about	Weighed about
1. Pair of shoes	______ kg	______ kg
2. The heaviest book in your room	______ kg	______ kg
You choose 3 more things:		
3. ______________	______ kg	______ kg
4. ______________	______ kg	______ kg
5. ______________	______ kg	______ kg

MASS AND SHAPE

This sheet is one of the first which is cast in the general mold of "experiments". It is therefore written as a very simple type of laboratory-oriented activity.

General Objectives:

1. Give the student experience in performing very simple experiments, then drawing a conclusion.

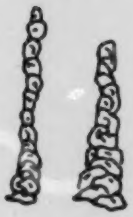
2. Help the student distinguish between different properties of objects, by differentiating the particular property of mass (amount of matter), and showing that it does not depend only on volume or shape.

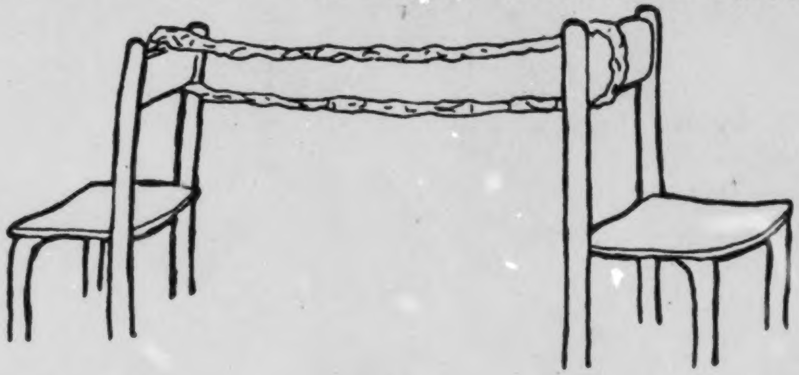
Comments:

Other activities of the same type could include a piece of clay, rolled into different shapes or blocks which use the same number of cubes assembled differently, to emphasize that the amount of matter is the important characteristic. To show that mass depends on the material chosen, further comparisons of light and heavy objects of identical size should be made. Mostly, at this point, the student should have a chance to develop enough experience with handling and weighing different objects to improve his intuition about light and heavy materials, and to begin to get some feel for mass as dependent on a combination of volume and density.

Other activities:

Students could try estimating masses. After some experience with clay, for example, students might try to make a ball which would be 50 grams. Then they could check to see how close their balls were. This could be turned into competitive activities (contests, either individual or in teams—a "mass relay" for example). Or you might review length concepts at the same time as students learn about mass, by giving each competitor or team a given mass of clay, then checking who can build the tallest tower (students could use the clay as a solid mass or separate it into strips for their constructions). The longest "suspension bridge" between two supports is another measuring project. If you like, conditions could be placed on the bridge,—that it must support a given mass in the middle (a clay loop works well).





MASS AND SHAPE

Mass: Conservation

General Objectives:

1. Give the student a chance to experiment with different shapes of the same mass.

2. Students should come to the conclusion that if the shape of an object is altered, its weight or mass remains the same.

Activities:

1. Using a piece of modeling clay, have the students change the shape of the clay and weigh the clay each time after the change is made.

2. Weigh a bag of corn or potato chips then smash the bag of chips and have the students weigh the bag again and compare the weight.

3. Weigh a piece of paper then crumple it into a wad and weigh it again and compare the two weights.

4. Weigh a set number of popcorn kernels then pop the corn and weigh it again and compare the two weights.

5. Weigh a certain number of ice cubes then melt the ice and weigh the water and compare the weights.

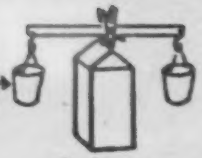
Equipment:

1. Materials suggested in the activities.
2. A balance or spring scale.
3. Metric weights for balance scale (if used).

MASS AND SHAPE

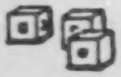
Try Some Experiments

You need


balance scale

1 10 cm wooden rod

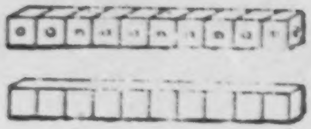
stacking masses


20 of the plastic centimeter cubes

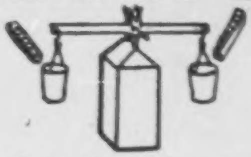
2 sheets of paper (both the same kind)

Do

1. Put together enough cubes to match one of the wooden rods. Did it take 10 cubes? ________ (It should)
   You now have a plastic rod the same size and shape as the wooden rod. Do you think they have the same mass, so they will balance each other? ________



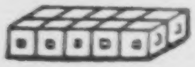
Try it



What happens? ______________________________

Why? ______________________________

2. Now put the other 10 cubes together to make a block like this:



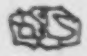
The block ________ (is, is not) the same shape as the plastic rod.

Do you think the plastic rod will balance with the block you just made? ________

Why? ______________________________ (Try it to check)

3. Try an experiment with the paper now. Fold one sheet neatly into a small rectangle (about 5 cm by 7 cm).

Crumple the other sheet.



Do you think they will balance? ________ (Try it.)

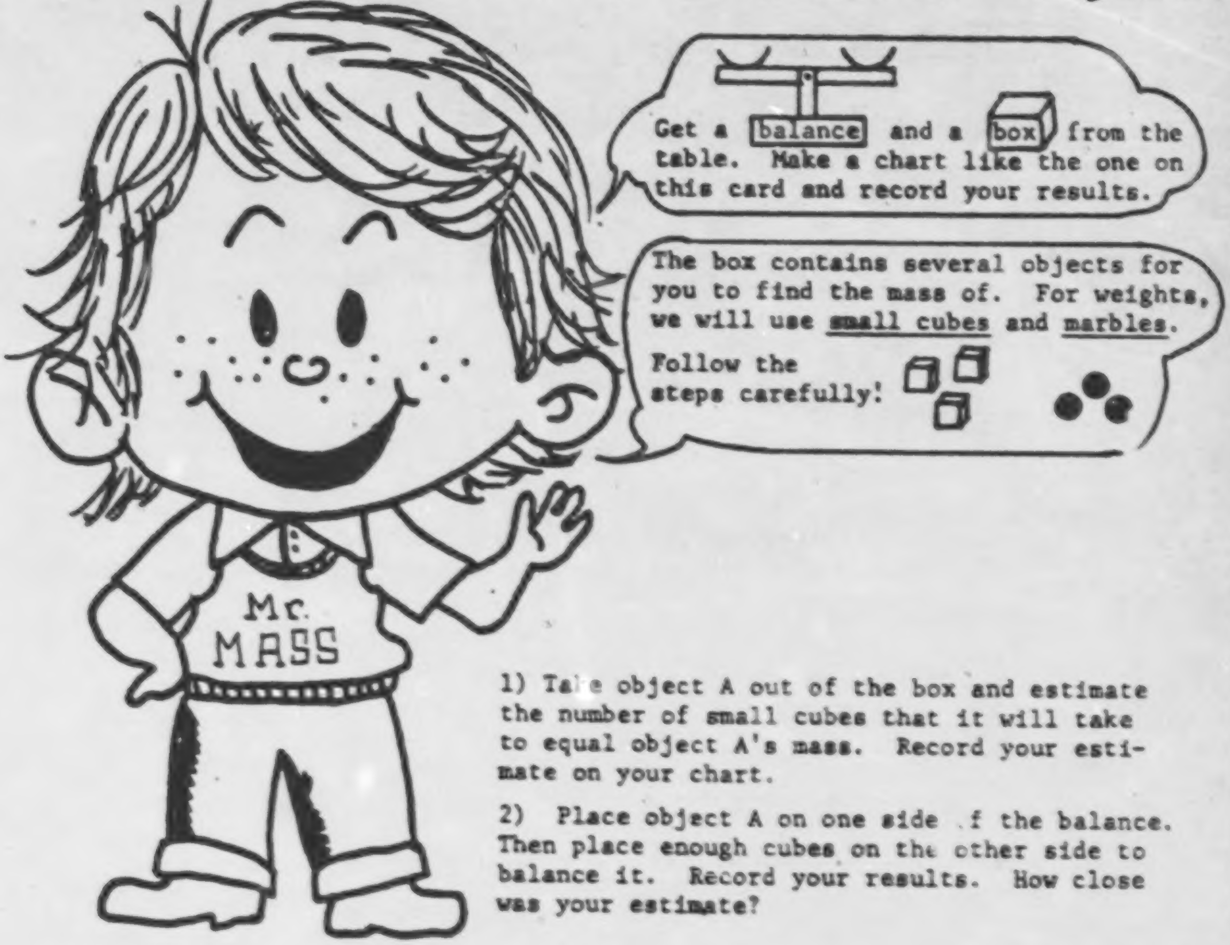
4. Another experiment with the cubes: Use your stacking masses to balance 10 cubes. It takes ______ grams. Try 4 cubes. It takes ______g. What do you think is the mass of 1 cube? ________ (Check it)

   Is the cube the same shape as the 1 gram mass? ________

Conclusion → Mass ________ (does, does not) depend on shape.

(The cubes in the kit are specially made. Each has a mass of 1 gram, so you can use the cubes for weighing, as well as the stacking masses.)

Finding the Mass of Classroom Objects



Get a balance and a box from the table. Make a chart like the one on this card and record your results.

The box contains several objects for you to find the mass of. For weights, we will use small cubes and marbles.

Follow the steps carefully!

1) Take object A out of the box and estimate the number of small cubes that it will take to equal object A's mass. Record your estimate on your chart.

2) Place object A on one side of the balance. Then place enough cubes on the other side to balance it. Record your results. How close was your estimate?

3) Remove the cubes. Pick up object A and estimate how many marbles it will take to equal the mass of object A. Record your estimate.

4) Use the marbles and the balance to find the actual mass of object A. Record your results. How close was your estimate?

5) Follow the steps above to first estimate and then find the actual mass of each of the other objects in the box, using cubes and marbles.

	Estimate Cubes	Actual Cubes	Estimate Marbles	Actual Marbles
Object A				
Object B				
Object C				
Object D				

SMALL OBJECTS

GET: 1 balance scale, 1 set of metric weights, 10 small objects

DO:
1. Line the objects across your table starting with the heaviest to lightest.
2. Estimate the weights of each object. Use the metric weights to help you estimate. Record your estimate.
3. Weigh each object. Record.

MORE:
1. Now guess the weight of your pencil. Check the weight.
2. Find something in the room that weighs: 20 grams 40 grams 100 grams

For the teacher

SMALL OBJECTS

Materials: Balance scales, one set of plastic gram weights, 10 small objects

Objectives:
1. Learn how to operate a balance scale.
2. Be able to arrange objects according to weight.
3. Estimate weights in grams.
4. Manipulate weights.

Procedures:
1. Have children work in small groups. Each group has one balance scale.
2. Give them 10 small objects. (Things found in room) Label each object.
3. Arrange them in order. (Heaviest to lightest) Record your choice.
4. Estimate the weights. Use the gram weights for comparisons.
5. Weigh each object. Record.
6. Check the actual weights with your estimate.
7. Have each group make a chart like the one below to record their estimates and actual weights.

OBJECT	MY GUESS	ACTUAL WEIGHT

The overall objectives of the following activities are to provide reinforcing experiences dealing with metric mass or weight. The area of food was chosen because of its high accessibility and familiarity to children. Materials are available by using packaged and canned foods that are weighed by grams and on which the contents are listed by grams.

ESTIMATING AND WEIGHING FOOD

For the teacher

Materials:
1. Various canned and packaged foods.
2. Spring scale calibrated in grams.
3. Paper to record findings on.

Objectives:
1. To learn to use the metric spring scale.
2. To practice estimating the weight of objects in grams by holding in their hands.
3. To be able to arrange objects according to weight.
4. To practice recording skills.

Procedures:
1. Divide the children in small groups of about six each. Each group should have a spring scale and approximately 6 to 8 different sized items of food. All labels on the items should be covered.
2. Explain the use of the spring metric scale to the entire group. Show techniques for estimating the weight of objects.
3. Ask the children to estimate and arrange the objects from light to heavy. A scale should not be used. This should be a total group process.
4. Record the arrangement of objects. Estimate the weight of objects in grams.

5. Check the actual weight of the objects on the scale. Record.

6. Rearrange the objects the correct way.

Activities:

1. Primary: Classroom Store-- Ask the children to bring in empty cans, boxes and cartons of foods from home. Before putting on the "store shelves", estimate what the total weight of the object might be if full. Dirt, sand or water may be used to fill the container for estimation. Label the container and the area on the shelf where it sits. The purpose of this activity is to reinforce the use of metric weight and the process of estimation.

2. Intermediate: Weight of Food for One Day or Week-- This may go along with a health or nutrition unit. The purpose of this activity is to reinforce the use of metric weights. Using some spring scales at home and others at school, weigh the amount of food that each child eats or plans to eat in one week or day. Precise records must be kept.

ESTIMATING AND WEIGHING FOOD

GET: 1. One metric spring scale

2. 6 to 8 food objects

DO: 1. Hold the objects in your hands, noting the differences in weight.

2. Line the objects across the table starting with the heaviest to the lightest. Make sure your whole group agrees.

3. Estimate the weight of each object and record the estimate.

4. Weigh each object on the spring scale and record the correct object. Were your estimations off?

MORE: 1. Exchange your objects with another group. Record correctly so that you can see which group estimated correctly.

2. Play "Let's Make A Deal" or any estimation game. Use your imagination.

DENSITY: Mass Compared to Volume

This sheet continues with the natural follow-up to the previous magic trick, with the students making comparative measurements of density (in a qualitative sense, more, less, between) so they understand why their trick worked.

General Objectives:

1. Provide further measurement experience, some to be quite carefully done, in a highly-motivating context.

2. Relate mass units to volume units, based on water as a standard. (In the metric system the base unit of mass, the kilogram, is the mass of 1 liter (1 dm^3) of water under controlled conditions (sea level atmospheric pressure, maximum density temperature, 4^0 C).

3. Introduce some scientific concepts: "light" and "heavy", as descriptions of materials, are related to density (mass/volume).

Comments:

Again, the objective is not a formal attempt to teach the science, but a demonstration of how measurement clarifies and explains previously vague ideas, and makes applications of the principles possible.

Students will probably be interested to learn that when their parents get automobile batteries checked at a service station, the measurement made is a specific gravity measurement. To check the battery acid, the mechanic uses a hydrometer. How high it floats in the solution gives a reading of the relative density of that solution.

Further Activities:

Students can measure many materials to compare their density to water. If both volume and mass are measured for an object, its specific gravity will be the quotient of g/cm^3 or kg/l.

You might pose a thought question: ask the students to consider the density of people. Fish, people, and most animals have about the same density as water. Depending on how much air you have in your lungs, you can either barely float or barely sink. A few people have specific gravity more than 1, so they will sink in fresh water. In salt water, on the other hand, just about everyone floats.

Teacher's page

METRIC WORKSHEET

The Meaning of Mass and Its Relationship with Volume.

1. This sheet is suitable for enrichment in grades 6 and 7 where it will be related to their science activities. In the metric materials, much emphasis has been placed on having students use the term "mass" but very little of the student material mentions what mass is or how it is different from weight.

2. Objectives:

   a. To recall concepts of mass, weight, and volume.

   b. To recognize how mass and liquid volume are related in the metric system.

3. To gain some idea of the larger units of mass in SI units.

Comments: Mass is the amount of matter/substance in an object. It is the same wherever it is measured. It is measured on a balance scale by means of comparison with the international prototype, the kilogram mass, on a body which has gravity, or by an inertia balance where force of gravity is zero. Weight is the force (pull) of gravity on an object. It varies as the force of gravity veries from place to place and is properly recorded in newtons (N), not grams (g).

4. Further Activities:

The power of a nuclear explosion is often compared to so many Mt of TNT. How many "school(s)-ful" volume of water will it take to equal a Mt mass?

Student's page

METRIC WORKSHEET

The Meaning of Mass and Its Relationship with Volume.

1. If you were transported from sea level and deposited on a mountain top 2 km high will your weight be the same? ____________

your mass? ________________________

We have a balance scale and a spring scale. Both have metric units.

Which will give you the same reading at both locations? ____________.

It balances you with an equal to that of gravity pulling on you.

What is weight?

What is mass?

2. Just as the Celsius temperature scale is based on the __________. Point (0^0) and the ____________ point (100^0) of water so is mass and volume related through water. Measure one liter (1 dm^3) of water and pour it into one of the plastic containers of the balance. Find its mass to the nearest 100 g.

Mass of 1 liter of water is ______________.

3. If 1 ℓ of water has a mass of ________________ kg

Then 1 kℓ of water has a mass of________________ kg

which is equal to ________________ mg

1 kℓ is the capacity of ____________ m^3

Therefore _________m^3 of water has a mass of ___________ mg

This unit of mass - the mg - is called a tonne (t).

e.g. A shipment of grain to Japan or Europe will be measured in tonnes.

DENSITY:

Mass Compared to Volume

You learned that the Celsius temperature scale is based on the freezing and boiling points of ________________ (water, air). Water is very important to life on Earth and very plentiful. Because water is so basic (sometimes Earth is called "the water planet") many of our measurements are based on water.

Mass is an example. The kilogram, a base unit for mass, is the mass of 1 liter(1 dm^3) of pure water (at sea level, at 4°C). 1 kilogram = ________ (how many) grams, and 1 liter = ______ ml, so 1 gram is the mass of _____ ml of pure water.

An object will float in water if its mass is less than the mass of the same volume of water. We say its density is less than the density of ____________ (air, water).

An object will sink if its density is ____________ (less, more) than the density of the liquid you put it in.

Try an experiment to see what happens to the density when you dissolve salt in water.

You need:

- balance scale
- masses from the kit
- 100 ml measuring beaker
- water
- salt

Do:

1. First weigh your beaker, empty. Its mass is ________ g. Fill in the second line of the chart.

2. Now put 95 ml of water in the beaker. Add about 15 ml (1 tablespoon) of salt, and stir until the salt is dissolved. Read the volume now. It is probably about 100 ml. If it is less than 100 ml, add water, a few drops at a time, until you have 100 ml. If the volume is more than 100 ml, soak up some water by dipping a small piece of paper towel in the liquid.

3. When you have 100 ml of solution, weigh it again, being careful not to spill any water. The mass is ________ g. Fill in the top line of the chart.

mass of beaker with 100 ml of salt water	________ g
mass of empty beaker	________ g
difference = mass of 100 ml of salt water	________ g

Fresh water has a mass of 1 g per ml, or ________ g for 100 ml.

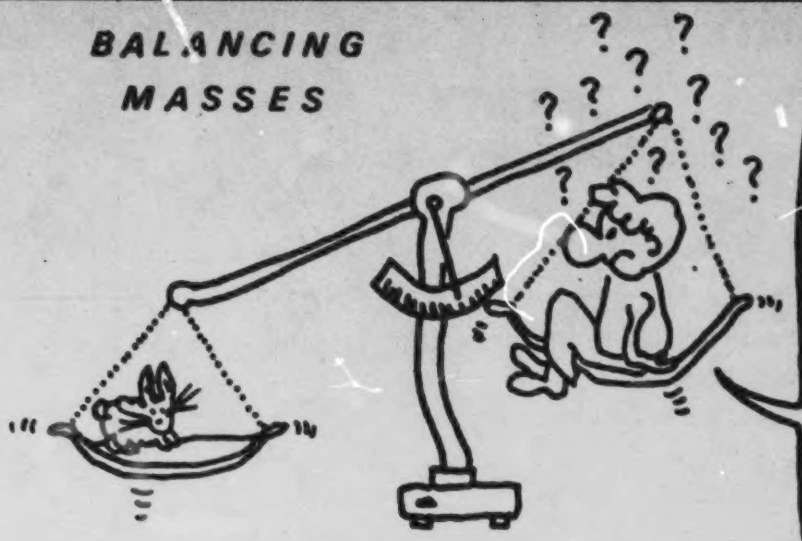
The salt water has a mass of ________ g for 100 ml.

The density of the salt water is ____________ (more, less) than the density of fresh water.

In your last experiment the plastic masses sank in plain water but floated in salt water. What can you say about the density of that plastic? ____________________
____

You can measure the density of the plastic if you want to. Use your 250 ml beaker. Put 150 ml of water in it. Then add enough plastic masses to raise the water level to 250 ml. Make sure that there are no air bubbles, and that all the masses are under water. The volume of the plastic equals its displacement (how much water it displaced). The displacement is 250 ml − 150 ml = ________ ml. Then empty the beaker and count how many grams of plastic masses. The total should be between the mass of 100 ml of plain water (100 g) and the mass of 100 ml of salt water

BALANCING MASSES



Get the balance and the box of masses and use them to help you answer the questions below. The first question is done for you.

1 kg = 500 g + 500 g ← Use 2 weights only!

1 kg = ? g + ? g + ? g + ? g ← Use 4 weights only.

1 kg = ? g + ? g + ? g + ? g + ? g ← 5 only.

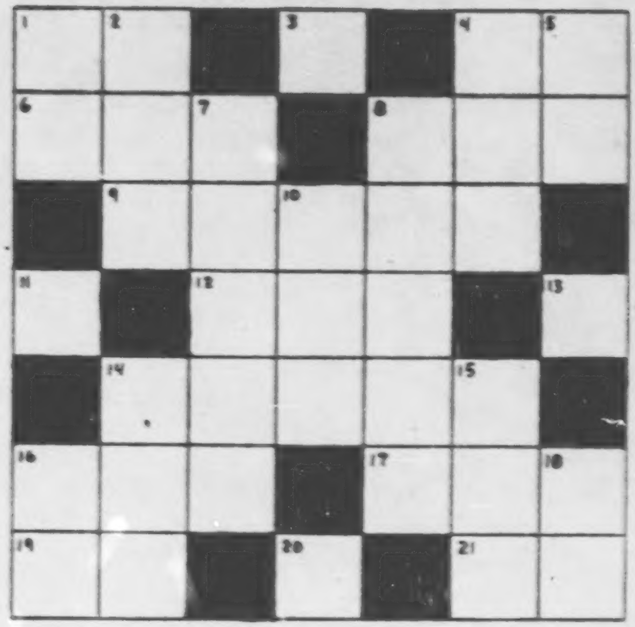
1 kg = ? g + ? g + ? g + ? g + ? g + ? g

500 g = ? g + ? g + ? g Use 3 masses only.

500 g + 500 g + 500 g + 500 g = ? + ?

Be sure to record your answers in your book!!!

MASS



Across

1. The heaviest domestic cat, Gigi, weighed about 19 kg. What is the weight of a cat 8 kg lighter? _____kg
3. A cubic centimeter of water weighs 1 gram. What is the weight of 7 cm^3 of water? _____g
4. .017 kg = _____g
6. A poodle weighed 3.514 kg before cutting and 3.387 kg after cutting. How many grams of hair were cut off? _____g
8. An office typewriter weighs about 18 kg. How much do 6 such typewriters weigh? _____kg
9. A taxi weighs 1875 kg. What is the total weight of 6 taxis? _____kg
11. A milliliter of water weighs 1 gram. What is the weight of 6 ml of water? _____g
12. The greatest weight lifted by a woman is 1620 kg. What would half that weight be? _____kg
13. A thirteen year old girl, weighing 45 kg, claimed that she weighed 1/9 that amount at birth. How much did she weigh at birth? _____kg
14. A small car weighs 1295 kg. What would 9 of these cars weigh? _____kg
16. The greatest weight lifted by a man is 2850 kg. What would 1/3 of that weight be? _____kg

17. .312 t = _____kg

19. A tennis racket weighs about 810 g. What would 100 of them weigh in kilograms? _____kg

20. Twins were born weighing 2.5 kg each. What was their combined weight? _____kg

21. One of the heaviest sets of twins on record had a combined weight which was double that of the twins in problem 20. What was the combined weight of the heavy twins? _____kg

Down

1. A two year old's weight is half of his brother's 22 kg weight. How much does the two year old weigh? _____kg

2. Eleven cats weighing 11 kg each are being weighed together. What is their total weight? _____kg

3. .007 kg = _____g

4. A football player weighs .1 t. How many kilograms is that? _____kg

5. A girl wishes to weigh 57 kg which is 21 kg less than she now weighs. What is her present weight? _____kg

7. 71.81 t = _____kg

8. Three trucks at a weighing station are recorded as follows: 5.006 t, 5.035 t, and 5.012 t. What is their total weight in kilograms? _____kg

10. A recipe calls for 108 g of sugar. If you are doubling the recipe, how much sugar do you need? _____g

11. If a liter of water weighs 1 kg, how much will 6 liters weigh? _____kg

13. If 1000 cm^3 of water weighs 1 kg, how much will 5000 cm^3 weigh? _____kg

14. An ex-heavyweight boxer claimed that he would need to lose 49 kg in order to get down to a fighting weight of 102 kg. What does he presently weigh? _____kg

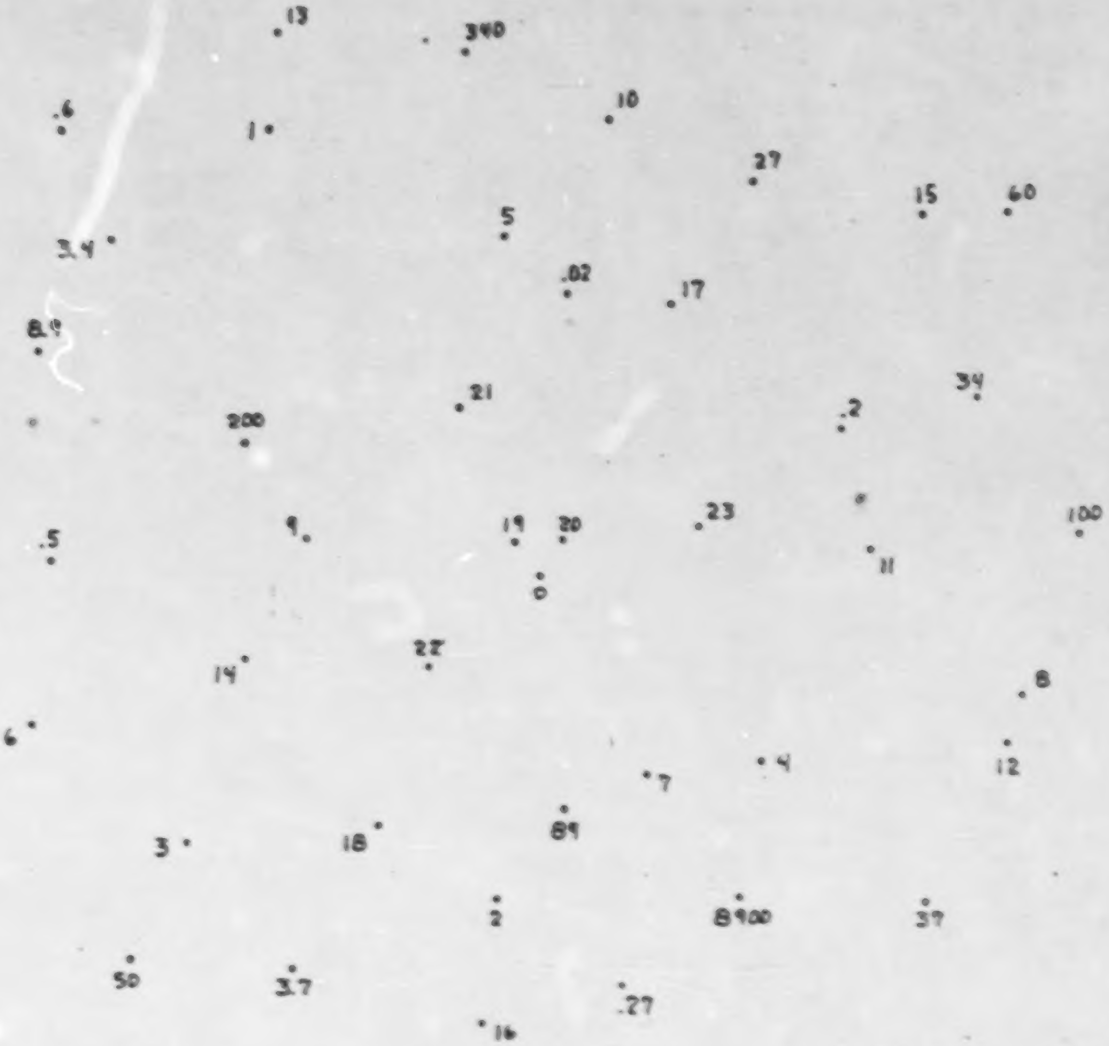
15. A bricklayer ordered .5 t of bricks, but found that the shipment weighed 11 kg too much. What did the shipment weigh? _____kg

16. .098 t = _____kg

18. A Dachshund weighs 13 kg more than a 7 kg Boston bull. What does the Dachshund weigh? _____kg

20. 5000 kg = _____t

OPERATIONS WITH MASS MEASUREMENTS


13
340
.6
1
10
27
15
60
5
3.4
.02
17
8.9
21
34
.2
200
100
.5
9
19
20
23
11
0
22
14
8
6
12
4
7
89
3
18
2
8900
37
50
3.7
.27
16

Connect the number of each problem with the answer for that problem.

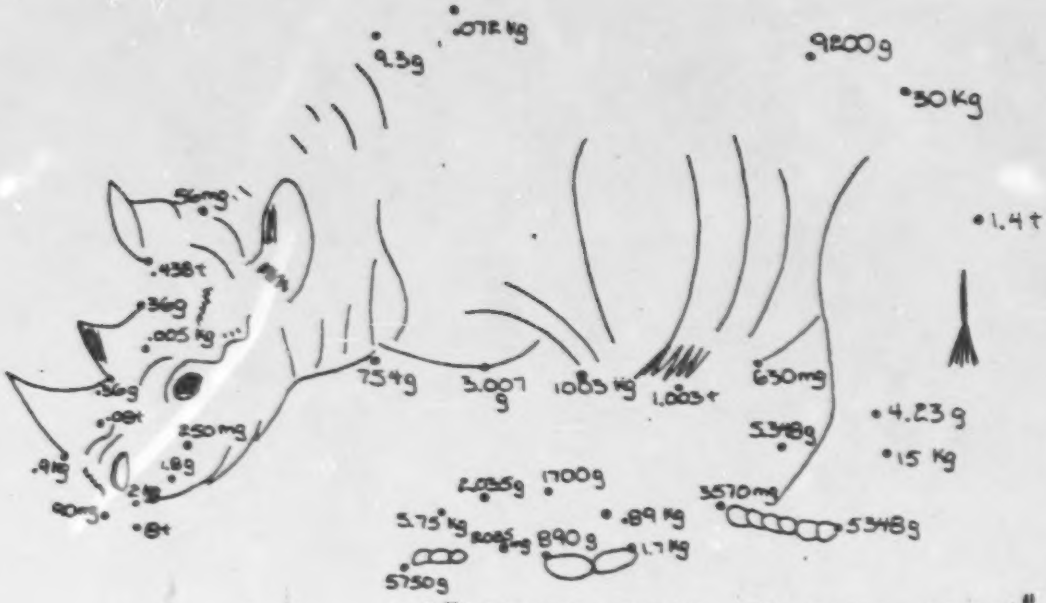
1. 9 g + 28 g = _____g
2. 73 t - 46 t = _____t
3. 15 kg + 19 kg = _____kg
4. 8 g + 900 mg = _____g
5. 8 g + 900 mg = _____mg
6. 3 g - 2.9 g = _____mg
7. 256 mg + 344 mg = _____g
8. 454 g + 46 g = _____kg
9. 1 kg - 800 g = _____kg
10. 1 g - 730 mg = _____g
11. .1 g + 100 mg = _____mg
12. 2345 mg + 1055 mg = _____g
13. 1 g - 911 mg = _____mg
14. 59 g + 1000 mg = _____g
15. 3 kg + 700 g = _____kg
16. 1 t - 660 kg = _____kg
17. .042 g + 8 mg = _____mg
18. 13 mg + 7 mg = _____g

MASS

Cut out the squares. Fit them together so that the touching edges name the same masses.

690 g 1 mg 300 dg 1.2 cg	.02 mg 10 cg 690 kg 1200 g	12 kg .03 t .01 g .03 mg	1.2 kg 30 g 300 kg 69 dg
1.2 dg .3 kg 1 dg .69 kg	6.9 g .1 kg .069 cg .012 t	120 cg .3 cg .003 t .12 kg	120 g 3 cg 3 g .3 mg
12 mg 3 kg 100 g 6.9 kg	.1 mg .069 mg 10 g 69 cg	6900 g 30 dg 30 kg 12 cg	12 g 69 kg 30 mg 120 kg
6.9 cg .3 g .1 cg 1200 mg	690 dg 10 dg 3 mg .012 kg	690 mg .01 mg 3 dg 69 g	.0012 kg 100 dg 300 g 69 mg

MASS


.072 kg
9.3 g
9200 g
30 kg
1.4 t
56 mg
.438 t
36 g
.005 kg
.36 g
.08 t
250 mg
.91 g
1.8 g
2 kg
90 mg
8 t
754 g
3.007 g
1.003 kg
1.003 t
630 mg
4.23 g
5.348 g
15 kg
2.035 g
1700 g
3570 mg
.89 kg
5348 g
5.75 kg
2035 mg
890 g
1.7 kg
5750 g

"MORE WHAM TO THE GRAM"

Connect the answers in order.

1. .25 g = _____mg
2. 1800 mg = _____g
3. 2000 g = _____kg
4. 8000 kg = _____t
5. .09 g = _____mg
6. 900 g = _____kg
7. 80000 g = _____t
8. 360 mg = _____g
9. 5000 mg = _____kg
10. .036 kg = _____g
11. 438 kg = _____t
12. .056 g = _____mg
13. 9300 mg = _____g
14. 72 g = _____kg
15. 9.2 kg = _____g
16. .03 t = _____kg
17. 1400 kg = _____t
18. 4230 mg = _____
19. 15,000 g = _____kg
20. 5 kg 348 g = _____g
21. 3 g 570 mg = _____mg
22. 5 g 348 mg = _____g
23. .6 g 30 mg = _____mg
24. 1 t 3 kg = _____t
25. 1 t 3 kg = _____kg
26. .8 kg 90 g = _____kg
27. .8 kg 900 g = _____kg
28. .8 kg 90 g = _____g
29. .8 kg 900 g = _____g
30. 3 g 7 mg = _____g
31. 2 g 35 mg = _____g
32. 2 g 35 mg = _____mg
33. 5 kg 750 g = _____g
34. 5 kg 750 g = _____kg
35. .67 kg 84 g = _____g

CHAPTER FIVE

THE METRIC MEASURE OF TEMPERATURE

INTRODUCTION

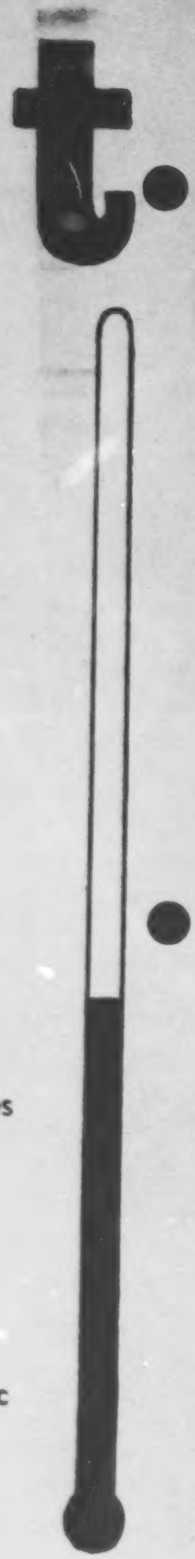
Temperature in the metric system of measurement is based on Celsius scale. Celsius, a Swedish scientist from the town Upsalla, has made a scale from zero to one hundred degrees; at zero degree he recorded the freezing of water and at one hundred degrees the boiling of water.

Matter expands when hot and contracts when cold, and this fact has been utilized in the building of a thermometer. Thermometers usually have mercury or alcohol as substance for expansion and contraction.

This chapter has the advantage over other chapters that it can be introduced to the class at any time and does not require to be preceded by other chapters.

The activities in this chapter are very interesting and amusing and the teacher should take full advantage of them in the classroom.

TEMPERATURE



My basic approach in teaching temperature to children of the elementary grades is to give them enough basics to go on - such as the differences in Fahrenheit and centigrade of the two thermometers.

For example in Fahrenheit water boils at 212°, whereas in centigrade it boils at 100°. Children should be given enough basic inferences to go on.

Dictionary use would be meaningful for the child to look up the words Celsius and Fahrenheit.

A child may bring in a Celsius thermometer and compare it with the one they normally use. A child may put both in ice water and record their results.

The Celsius thermometer can be used for forecasting the weather, testing the bath water, or signifying when a roast is done. This scale became part of the metric system in 1927.

Temperature is a name for some condition in matter which determines the direction and extent of transfer of the kind of energy we call "heat."

All temperature scales now share several common characteristics: All are anchored firmly to the two temperatures at which water, and no other substance, changes its state (steam, ice) under standard atmospheric pressures.

Following is a list of activities and experiments that would help you gain more insight into understanding temperature.

General Objectives:

1. Provide the student with strong visual references which will reinforce his "feel" for different temperatures.

2. Provide the student with the use of the temperature scale and how to read it.

3. Provide a few simple experiments to familiarize the student with the thermometer through actual handling and use.

Comments:

This will be a prime opportunity for teaching safety in using a thermometer. A few points to stress:

1. Always shake the mercury down over a bed or couch; doing it over a sink or hard surface could result in a shattered thermometer.

2. Don't bite the thermometer; rest it under the tongue. Why under the tongue? The bottom of the tongue is the closest area where very little air can get in.

3. After each use, always sterilize the thermometer in alcohol.

Further Activities:

Set up a chart for keeping records of the temperatures taken earlier (myself, thumb, goldfish) for a longer period of time. Note the differences from week to week.

Take student temperature when there is a cold or infection. Note the difference between normal body temperature and this temperature.

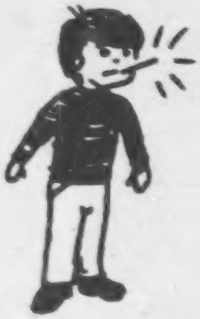
How does a Thermometer Work?

The liquid in the tube expands (its volume gets bigger, so it takes up more room) when it gets warmer. That forces it up the tube.

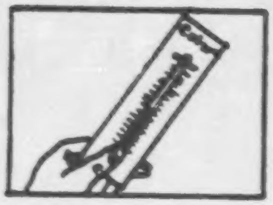
When it is colder, the volume of the liquid shrinks, so it doesn't reach as high in the tube.

THOUGHT QUESTION

If Johnny's temperature was 40° C one morning, should his mom send him to school or take him to the doctor? ____________________



DO SOME EXPERIMENTS



1. Hold the thermometer like this until the liquid stops rising. What does it read? ____________ ° C

2. Take your own temperature. What does the thermometer read? __________ ° C

   Run in place until the count of 50 and then take your temperature. Is it the same or different from the previous reading? ________________. If it is different, what was it? ________________ ° C

   What is the difference in temperature between holding your thumb on the thermometer and taking your temperature under your tongue? ________ ° C. Is it higher or lower under your tongue? ________________.

3. If my temperature is 37° C, what do you think the temperature of the goldfish is? Guess the temperature. ______ ° C. Now take its actual temperature. What is it? ________ ° C. (Remember that the temperature of the water is the same as the temperature of the goldfish.)

CHART YOUR FINDINGS

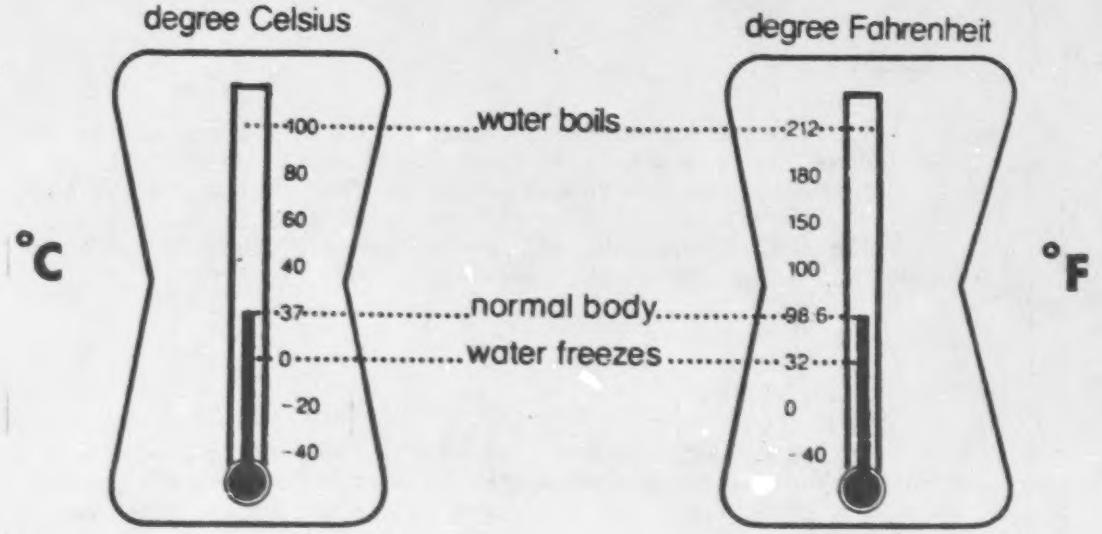
	TEMP
THUMB	
MYSELF	
MYSELF (Exercised)	
GOLDFISH	

THERMO-METER

F to C

-459.67 = -273.15	55 = 13
-40 = -40	60 = 15.6
-30 = -34	65 = 18.4
-20 = -29	70 = 21.1
-10 = -23	75 = 24
0 = -18	80 = 26.7
10 = -12.2	85 = 29.5
15 = -9.5	90 = 32.2
20 = -6.7	95 = 35
25 = -3.9	98.6 = 37
30 = -1.1	100 = 37.8
32 = 0	102 = 39
35 = 1.7	104 = 40
40 = 4.4	106 = 41
45 = 7	200 = 93
50 = 10	212 = 100

METRIC TEMPERATURE


degree Celsius
degree Fahrenheit
°C
°F
100
80
60
40
37
0
-20
-40
water boils
normal body
water freezes
212
180
150
100
98.6
32
0
-40

TEMPERATURE

General Objectives:

1. Provide the student with experience in reading a thermometer.
2. The student will realize the many ways a thermometer is used.

Materials:

Large butcher paper thermometer marked in centigrade; various strips of red paper; student worksheet.

Comments:

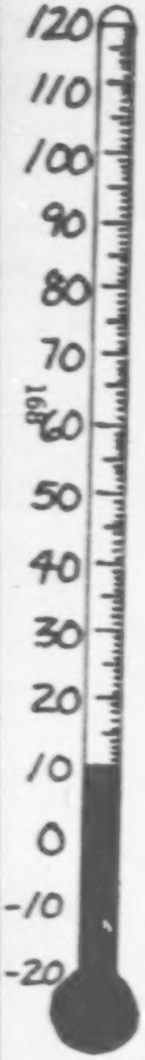
Put the large thermometer on the board. Have a discussion about the thermometer and why it is used. Talk about the division on the thermometer. Put a red strip on the thermometer and ask the class if anyone can tell what mark the red comes up to. Repeat this with the other strips of paper. When the students are able to do this, have them do the worksheet.

Further Activities:

Have the students make a list of all the different ways and all the different places a thermometer is used. They might also want to make a list of all the different people and occupations that use a thermometer.

TEMPERATURE

Can you read these thermometers? See if you can read the temperatures and write them on the line below each thermometer.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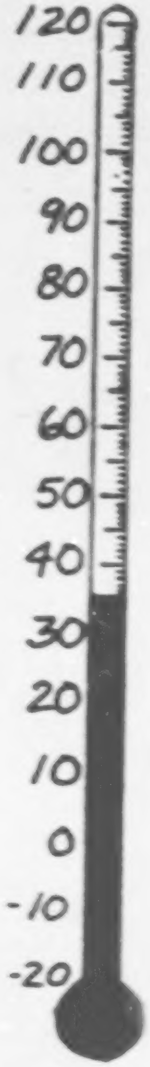
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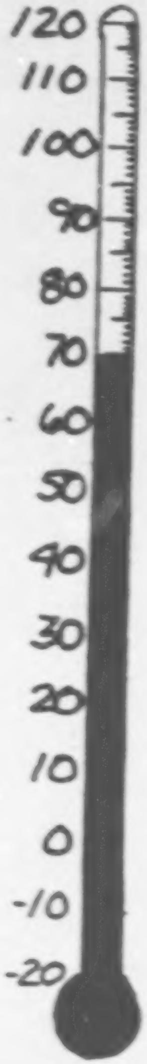
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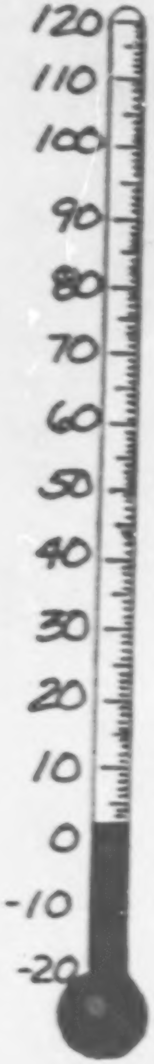
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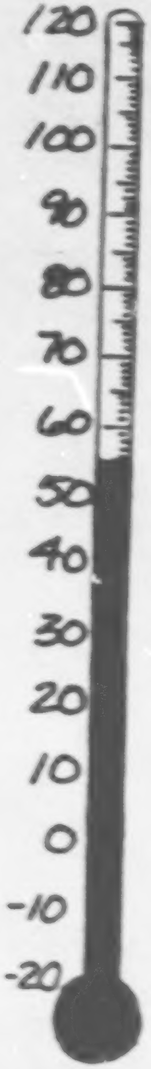
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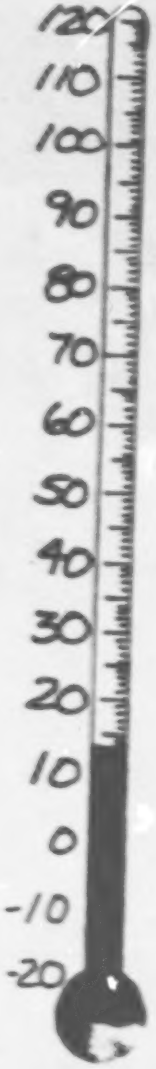
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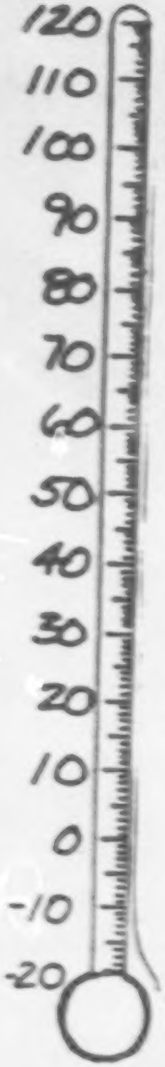
120
110
100
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70
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50
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30
20
10
0
-10
-20

This thermomete is for you to fill in. Give it to a friend and see if he can read it

______

TEMPERATURE

General Objectives:

1. The student will realize why thermometers are needed.

2. The student will be able to make his own primitive thermometer.

3. The student will be able to describe how a thermometer works.

Materials;

Three pans; hot, warm and cold water; ice; worcestershire sauce bottle (any small narrow-necked bottle will do); food coloring.

Comments:

This activity is designed to give the student hands-on experience in making his own thermometer and recognizing the general principle under which a thermometer works. A discussion should be held as to why the water level rose in hot water and dropped in cool water.

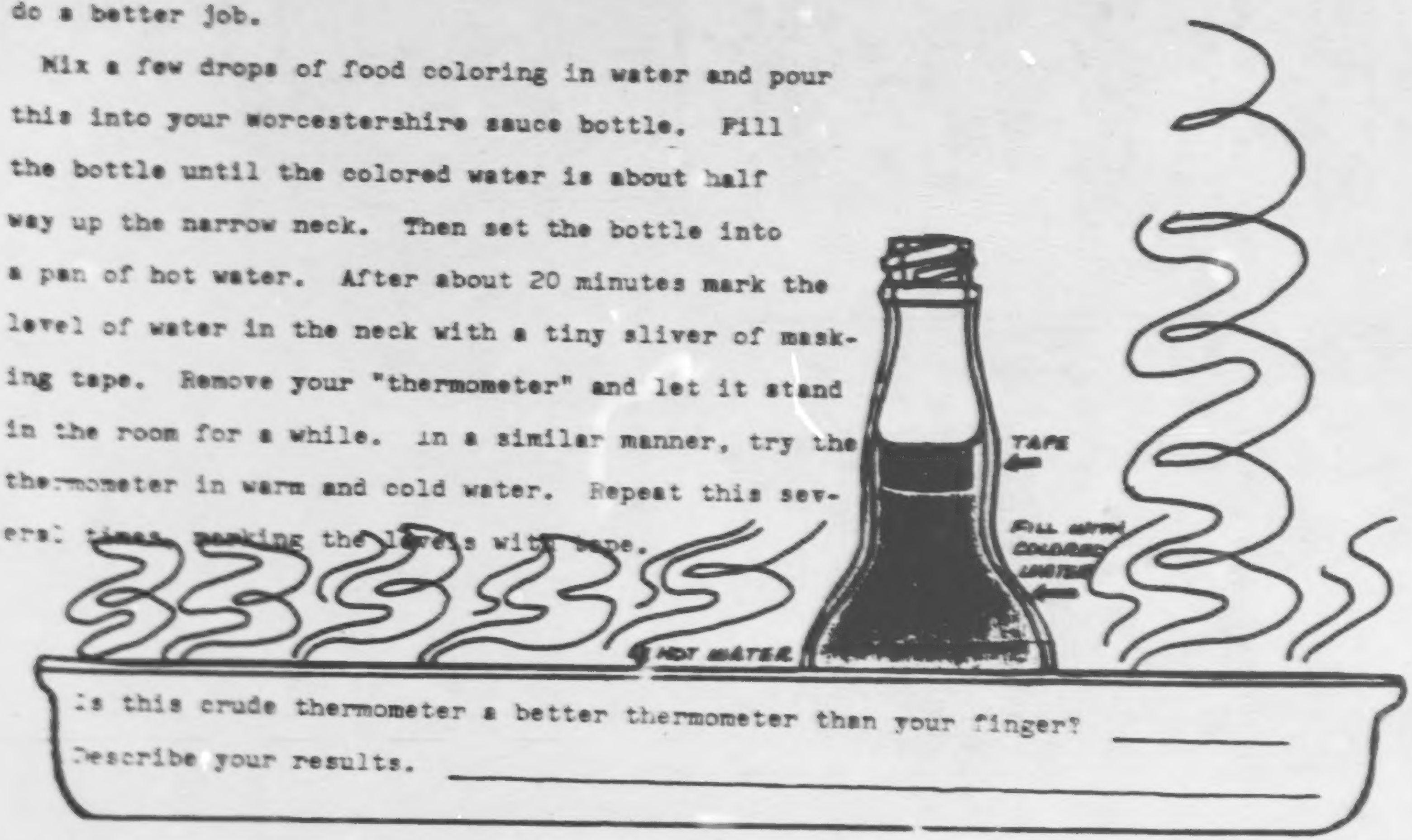
Further Activities:

Have the students find small bottles with wider or narrower necks to test the idea that the narrower the neck of the bottle the greater the change is observed.

TEMPERATURE

Our "feeling" is not a very good temperature indicator. Let's see if a simple thermometer can do a better job.

Mix a few drops of food coloring in water and pour this into your worcestershire sauce bottle. Fill the bottle until the colored water is about half way up the narrow neck. Then set the bottle into a pan of hot water. After about 20 minutes mark the level of water in the neck with a tiny sliver of masking tape. Remove your "thermometer" and let it stand in the room for a while. In a similar manner, try the thermometer in warm and cold water. Repeat this several times, marking the levels with tape.



Is this crude thermometer a better thermometer than your finger? ____________

Describe your results. ____

TEMPERATURE

THOUGHT QUESTIONS

1. Have you ever heard one person in your family complain that it was cold in your home when another thought it was just right? _____

2. Do hot, cold, and just right mean different things to different people? _____

3. Do you suppose a hot day to an Eskimo would be the same temperature as a hot day to someone in Phoenix, Arizona? _____

4. Your simple thermometer might have been better than measuring temperature with your finger, but is it as good as a modern store-bought thermometer? _____

   Explain why. ______________________________

5. What happens to water when it gets very cold? ______________

6. What happens to water when it gets very hot? ______________

7. So water has two points - hot and cold - that are easy to see. What would be good names for these two points?

   _________ and _________

TEMPERATURE

General Objectives:

1. The student will find and recognize the freezing and boiling points on a centigrade thermometer.

2. Provide some experience for the student in reading the thermometer.

Materials:

Containers; ice cubes; water; centigrade thermometers (1 per every 2 students if possible)

Comments:

It is important that the ice water be just ice and melted ice. Do not add tap water to the mixture. Place the thermometer bulb as close to the center of the mixture as you can. Be sure to have the student leave the thermometer in long enough for the red line to stop moving.

Further Activities:

Have the students quess what might happen to the temperature if the thermometer was left in the ice water after the ice had all melted. Have the students test their ideas. Do the same type of activity with the boiling water.

TEMPERATURES

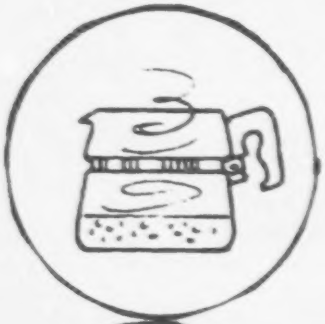
We know that there are two standard points on a thermometer, the boiling and freezing points. Let's see if we can find the boiling and freezing points on a centigrade thermometer.

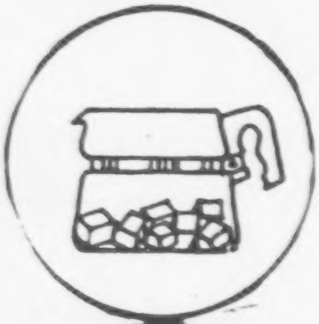
Put your thermometer in a boiling pan of water. Wait for the red mark on the thermometer to stop moving. When it does stop moving, read it. What does it say? ______________________

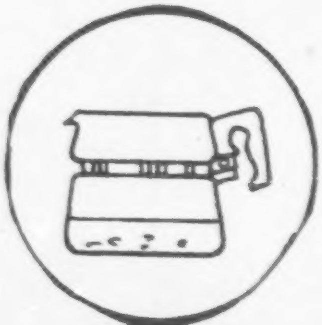
We now have one standard point on our thermometer. But what about the other point-the freezing point?

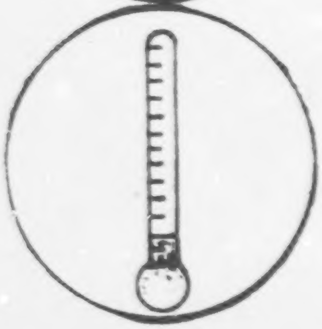
Fill a container with ice cubes. After the cubes have melted a bit, place any ordinary thermometer into the water. Once the red line stops moving what is the temperature reading? ____________________ Does the reading change? ______________ This temperature is called the freezing point. So now we have a second point on our thermometer.

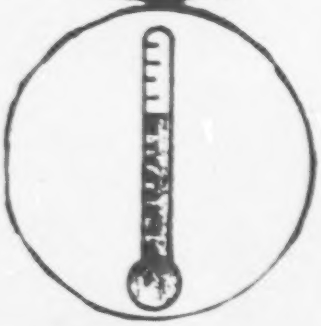
Match the coffee pots with the correct thermometer. Draw a line from the right coffee pot to its thermometer.

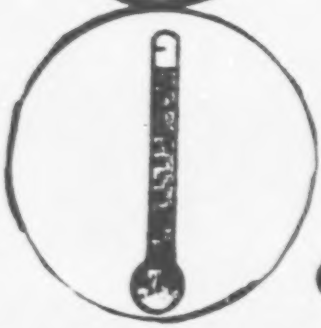












TEMPERATURE

General Objectives:

1. The student will begin to get a "feel" for centigrade temperature and begin to re-think in terms of centigrade.

2. Provide the students with experience in reading the thermometer.

3. Provide the student with experience in recording data on a table.

Materials:

Centigrade thermometer attached to the outside of the building; student recording sheet

Comments:

Attach the thermometer to the outside of the building where the students can read it easily. The thermometer should be read at least twice daily and each student should have the opportunity to read the thermometer at least once. Each student should record the results. Do this for at least two weeks. Discuss the results. (The students should begin to get the "feel" for centigrade.)

Further activities:

Have one student be the "weatherman". Have him announce a temperature, the class should see if they can guess what the weather would be like.

TEMPERATURE

date	time	temperature	weather description	suitable clothing

TEMPERATURE

General Objectives:

1. Provide the student with more experience and opportunity in thinking in terms of centigrade.

Materials:

Study prints (snowy day, sunny day, etc); student worksheet

Comments:

Put a study print up on the board and ask the students, "If you looked out your window and saw the following scene, what would the temperature be in centigrade? After doing this several times, have the students do the worksheets. Discuss.

Further Activities:

Have the students make up their own questions about the centigrade thermometer and temperature to see if they can "stump" their friends.

TEMPERATURE

C or F
I'm still sick!

1. Your popsicle is placed in a refrigerator at 32°C. Will it keep? ______

2. Your bath water measures 45°C. Will you shiver? ______

3. Your teakettle has just started to boil. Is it now 212°C? ______

4. Ice has begun to form on a puddle, the thermometer reads o°C. Right? ______

5. It's 50°C, do you need a fan? ______

6. There are 100° on a Centigrade from water freezing to boiling. Right? ______

7. The Doctor uses a thermometer and says you have a 35°C temperature. Are you above normal? ______

8. C temperatures in the seventies are comfortable in a classroom. Right? ______

9. Temperature readings can go below zero on F scale but not on the C scale. Right? ______

TEMPERATURE

General Objectives:

1. Give the student experience in estimating temperatures.
2. Give the student opportunity in reading a thermometer.
3. Give the student experience in recording data.

Materials:

Centigrade thermometer; student worksheet; cold tap water; hot tap water; ice water; ice water with salt

Comments:

Using the thermometer on their worksheet, have the students estimate the temperatures of the 8 items at the top of the page. Discuss their results. Then have them estimate the things at the bottom of the page by feeling. Record their estimate. Have them take the temperatures of the same things. Record.

Further Activities:

For more work with estimation, have them estimate the following: air temperature in the classaromm near the ceiling, in the classroom near the floor, near the radiator or heater, in the hallway, outside temperature in the sun, outside temperature in the shade, in a refrigerator, in a freezer. Have them record their estimates. Then have them take the temperatures in centigrade.

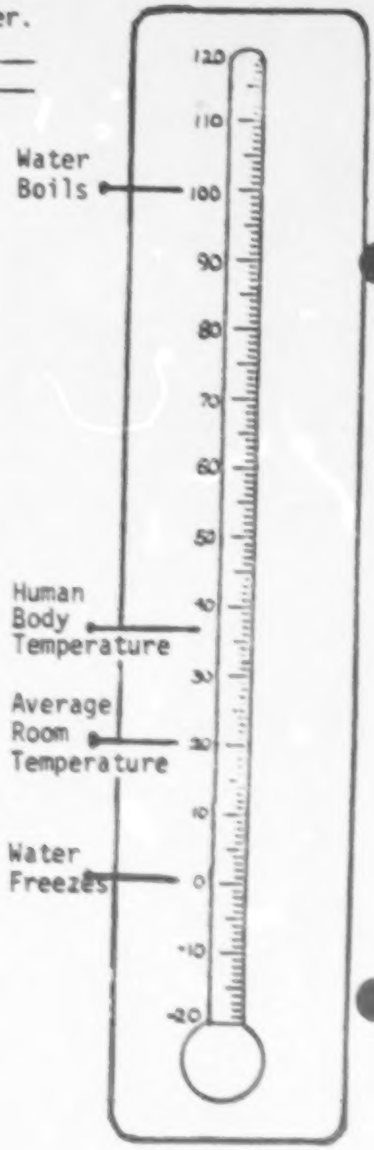
TEMPERATURE

Using the thermometer on this page, estimate (guess) the temperature of the following things: Write your estimates out to the side.

1. A very hot day in summer. ____________
2. A very cold day in winter. ____________
3. A bowl of hot soup. ____________
4. Ice cream. ____________
5. A warm bath. ____________
6. A glass of cold soda. ____________
7. The coil of an electric coffee maker. ____________
8. A person with a fever. ____________ ____________

Now estimate the temperatures of the following items. When you've finished estimating, use the Centigrade thermometer your teacher gives you to take their temperatures. Record the temperatures. Discuss your results with your teacher.

	Estimate	Temperature
1. cold tap water		
2. hot tap water		
3. ice water		
4. ice water with sale		


120
110
Water Boils
100
90
80
70
60
50
40
Human Body Temperature
30
Average Room Temperature
20
10
Water Freezes
0
-10
-20

TEMPERATURE

General Objectives:

1. Provide the student with experience in reading a thermometer.

2. Provide the student with experience in graphing results of an experiment.

3. Provide the student with the experience of transferring date from a table to a graph.

Materials:

Centigrade thermometer; boiling water, coffee mug, styrofoam cup, tin cup, aluminum pan, thermos jug, ordinary bowl. The student will also need the worksheet and graph paper.

Comments:

Have the students use a centigrade thermometer to measure the temperature of water at five minute intervals. Let the water stand, take readings at five minute intervals and record the results. Use equal quantities of water. Graph the results.

Further Activities:

Do the same activity starting with ice water.

TEMPERATURE

Using a Centigrade thermometer take the temperature of hote water in different containers. You'll need to take the temperature every 5 minutes. Be sure to record the time you take the temperature. Discuss the results with your teacher. When you've finished, graph your results.

temperature

time	coffee mug	styrofoam cup	tin cup	aluminum pan	thermos jug	ordinary bowl	heavy soup bowl

HOT AND COLD

What Happens When You Mix the Two?

This sheet has the student do some experiments which quantify observations which he has made over the course of the years. We start with something which is part of the student's intuitive knowledge through his experience; then we extend the observations.

General Objectives:

1. Provide the opportunity for more manipulative experience with temperature measurements, using the thermometer.

2. Lead the student to establish hypotheses ("guesses"), check them, do further experiments to refine his analysis, then draw a conclusion.

Comments:

The student starts with the "knowledge", from experience, that if he mixes hot and cold, he will get something in between. The experiments he performs call for variation in temperatures and quantities of water mixed. Each time, he is asked to make a guess first at what the temperature will be, then to perform the experiment and check his guess. Finally a thought question asks the student to look for a pattern in his results, then state the pattern if he can.

In the process of performing the experiments and recording the data, the student continues to get practice in making volume as well as temperature measurements, and in using a chart for his data.

Further Activities:

More activities of this type can be performed. Select temperatures and quantities which are easy to work with and which will point to the ratio patterns in the mixing results. Use large enough volumes so the temperature changes over the period of time the experiment takes will not affect the readings significantly.

The results on this page will not surprise your students at all. They fit eminently well with the student's logical expectations. You are in a certain sense deliberately setting the students up for a surprise in the next lab sheet, where they continue to mix warm and cold and wind up with "magic" instead of logic.

HOT AND COLD:

What happens when you mix the two?

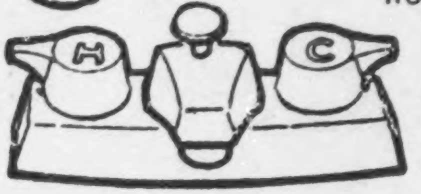
You mix hot and cold water quite often. Here are some experiments to measure what happens.

You need:

the thermometer from the kit

measuring beakers (250 ml, 400 ml, 1000 ml would be good to use)

hot and cold water from the faucet



chilled water from a water-cooler or a refrigerator

Do:

1. Put 200 ml of cold water from the faucet in the 400 ml container. Put the thermometer in the water.
2. Put 200 ml of hot water from the faucet in the 250 ml container.
3. Read the temperature of the cold water. ________°C
4. Now put the thermometer in the hot water. When the reading stops changing, read the temperature. ________°C
5. What do you think the temperature will be if you mix the two? ______°C
6. Try it. Pour both into the 1000 ml container. Mix them and read the temperature. ________°C Then fill in the top line of the chart.
7. What do you think will happen if you mix 200 ml at 40°C and 200 ml at 10°C? Fill in your guess on the second line. Then try it. You should be able to get 40°C water from the hot water faucet if you let the water run for a while, but 10°C is probably colder than you can get from the cold water faucet. You'll need to use some chilled water to get the temperature right. Fill in the result of the experiment (what actually happened) on the second line of the chart.
8. What do you think will happen if you mix 400 ml at 10°C and 200 ml at 40°C? First fill in your guess. Then try it and fill in the chart.
9. What will happen if you mix 200 ml at 10°C and 400 ml at 40°C? First try to guess; then do the experiment.

	cold water		hot water		mixture	
	amount ml	temp °C	amount ml	temp °C	guess °C	read °C
1.	200		200			
2.	200	10	200	40		
3.	400	10	200	40		
4.	200	10	400	40		

Thought question: Do you seem to see a pattern? State it if you can.

SCIENCE MAGIC

More About Mixing Warm and Cold

This sheet builds on the student's previous experience and continues with some temperature experiments which bring unexpected results.

General Objectives:

1. Provide motivated practice with volume and temperature measurements.

2. Demonstrate a new bit of "magic" based on scientific principles and indicate how those principles are applied in making ice cream.

Comments:

You may prefer to do these experiments first as a classroom demonstration, since they are fairly dramatic. The students will probably be quite intrigued by the unexpected results and will want to repeat the experiments themselves anyway.

The students already "know" that mixing things at two different temperatures results in an in-between temperature. Now they find that this obvious fact is not always true. Even if the ice comes directly from a freezer at -20° C, no matter how much ice is added to an ice-and-water mixture at 0° C, the temperature will not go any lower. (It is equally true that once you have brought water to boiling in an open pot, you cannot raise the temperature any higher, no matter how much heat you apply to your pot.)

After the student has found that adding ice does not lower the temperature of an ice-water mixture, he is ready for the next surprise. He adds salt at a higher temperature than the ice-water. In response, the temperature goes down several degrees! This is, of course, the reason for using an ice-salt mixture when making ice cream. We need temperatures below 0° C to freeze ice cream.

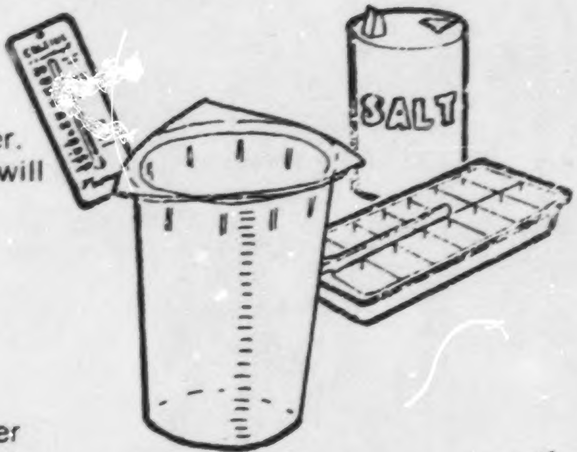
Further Activities:

Other interesting activities include making a demonstration thermometer to show how the thermometer works, getting a blank thermometer and calibrating it as another example of making additional standards for measuring, or learning about the odd behavior of many materials at ultra-cold temperatures.

SCIENCE MAGIC:

More About Mixing Warm and Cold

The experiments you're going to do next may bring some surprises.



You need:

The thermometer from the kit.

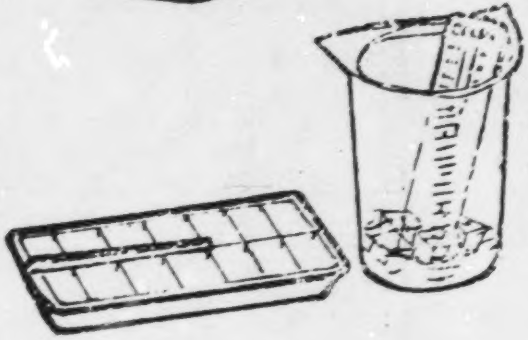
A container in which you can put water. (The largest beaker in the kit, 1 000 ml, will work well.)

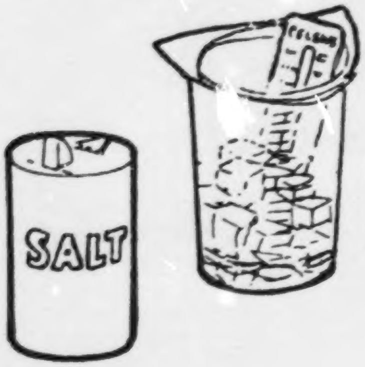
A small amount of cold water.

Enough ice to fill the container half-full.

About 100 ml of salt.

1. Put most of the ice in the container. Either wait for some ice to melt or add a small amount of water, just enough so the bulb of your thermometer would be in water when you want to read the temperature.
2. Mix the ice and water well. Then read the temperature. ________°C
3. Add the rest of the ice. Read the temperature again. ________°C. (No matter how much ice you add, once the temperature is at 0°C, adding more ice will not make it any colder!)

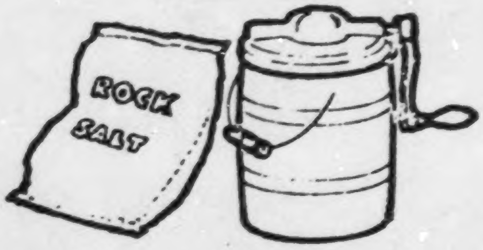




4. The salt is at room temperature. Is that warmer or colder than your ice-water mixture? ____
5. What usually happens to the temperature of the mixture when you mix warm and cold? The temperature ______________________________
____
6. Try it. Add the salt to your ice-water and mix vigorously. Then read the temperature. ________°C
7. When you added the salt, the temperature went down instead of up!

When you study "latent heat" in high school chemistry or physics class you will learn why such seemingly "magic" things happen.

We use the fact that adding salt will lower the temperature when we want to make ice cream. We put the container of ice-cream mix inside a bucket holding an ice-water-salt mixture.



Science Magic Application

This sheet builds on the knowledge that salt will lower the temperature of ice. We will use this fact to make ice cream.

General Objectives:

1. Provide motivational practice with volume and temperature measurements.

2. Review the "magic" showing salt lowering the temperature of ice.

3. Apply these principles to make ice cream.

Comments:

The students start with the knowledge from the previous experment that adding ice does not lower the temperature of an ice water mixture. But that adding salt at a higher temperature does result in the temperature going down several degrees!

They are now ready to experiment and make their own ice cream. During this process they will get practice in measuring volume, besides measuring temperature.

Vanilla Ice Cream Recipe:

This mixture is made in advance by the teacher. (Perhaps one day using the metric units of measure.) It should be stored in the freezer.

1 1/2 teaspoons vanilla	1/4 teaspoon salt
1 1/2 cups milk	3/4 cups sugar
1 tablespoon cornstarch	4 egg yolks
	1 1/2 cups whipping cream

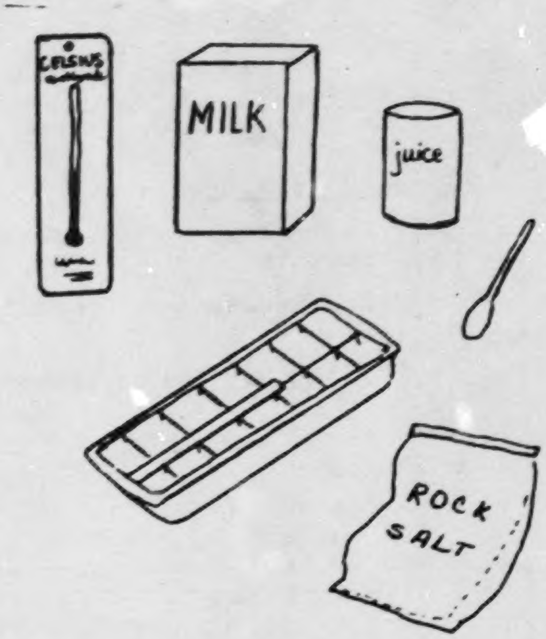
Combine cornstarch, salt, sugar, and slightly beaten egg yolks, and mix well. Beat in a little of the scalded milk, then combine the two mixtures and cook over a low heat or in a double boiler, stirring constantly, until thick and smooth. Add vanilla. Chill, then stir in cream.

Further Activities:

Other activities of this type can be performed to discover methods of raising the temperature over 100°C. Select temperatures and quanties which are easy to work with and will show significant changes.

Enjoying Metric Magic

This experiment will help you remember that salt lowers the temperature of ice, because we will make ice cream.



You Need:

The thermometer from the kit.

A small juice can.

A litre milk caron.

About 100 ml of rock salt.

A spoon

Ice

Do:

1. Put most of the ice in the milk carton. Add enough water so that the thermometer bulb will be covered.

2. Mix the ice and water well. Then read the temperature. _______° C.

3. Put the juice can (about 2/3 full of ice cream mixture) into the ice, making sure that the ice goes around the can.

4. Stir the ice cream mixture for two minutes. Then read the temperature. _______° C.

5. Put the rest of the ice into the milk carton. Read the temperature again. _______° C. (Again, adding more ice will not make it any cooler!)

6. The rock salt is at room temperature. Add it to the ice-water and mix vigorously. Then read the temperature. _______° C.

7. The temperature went down. These are the conditions needed to make ice cream. Stir away and enjoy! (This will probably take ten minutes.)

STUDENT ACTIVITY

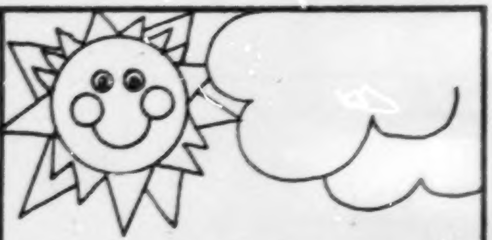
METRIC MATH WORD PUZZLES

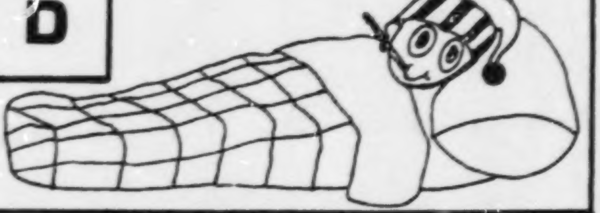
T	E	N	W	
H	°C	37°	A	
O	Z	E	R	O
T	C	R	M	
I	C	O	L	D

My 6 temperature words are:

STUDENT ACTIVITY

METRIC MATH WORD PUZZLES





M					C				
E				D	O				
A			C	E	L	S	I	U	S
S				G	D				
U			M	R					
R	F	R	E	E	Z	I	N	G	
E	H	O	T	E		E			
	W	A	R	M			R		
	B	O	I	L	I	N	G	O	
		I	C	E					

My 10 temperature words are:

About Cooking With Metrics

General Objectives:

1. Provide an experience in cooking to familiarize the students with a metric cooking thermometer and/or a metric oven gauge.

2. Give motivated practice in measuring recipes in metric units.

Comments:

The following four recipes can be used in demonstrating metric cooking. Each recipe is made using a different method, so that most teachers could find at least one appropriate for their situation. To the instructors having hot plates or ovens in their schools, there are the 'Salt Water Taffy' and 'Munchy Squares' recipes respectively. The 'Spice Round Cake' is geared to the Toaster Oven, while the "After Lunch Peppermint Crunch" is for teachers having no means to heat ingredients, but would like to expose their students to measuring in metric units.

Metric measuring cups are now available on the market. Celsius thermometers for cooking however, are limited. If one were to choose the 'Salt Water Taffy' recipe, the school's science department probably would have immersible Celsius thermometers suitable for cooking. If these are not available either, the conversion table written on the taffy recipe page might be helpful.

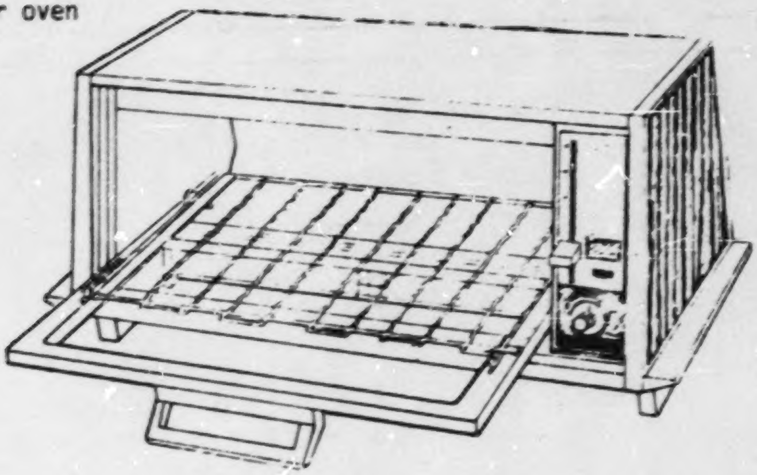
Further Activities:

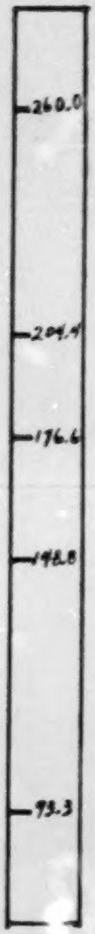
After the following experiments, a kitchen conversion table is included. Students who are interested may want to try converting their own recipes from home. Adventuresome pupils may want to invent their own metric recipes, cook them, and serve them to the class.

COOKING WITH METRICS

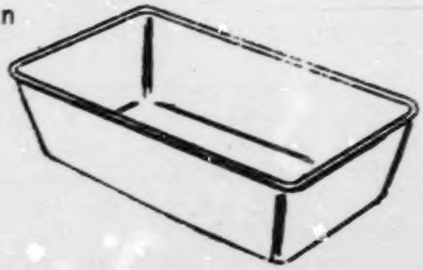
You need:

a toaster oven





a 1.425 liter (1½ qt.) loaf pan



metric temperature strip for the oven

ingredients for the Spice Round Cake

measuring utensils

EXPERIMENT

Using the following recipe, mix and bake the ingredients according to the metric units.

Spice Round Cake (taken from Delux King Size Toaster Oven T-94, page 22)

60 m. softened butter or margarine
125 gms sugar
1 egg
30 ml light molasses
45 ml milk
250 gms all-purpose flour

2.5 gms baking soda
2.5 gms ground nutmeg
2.5 gms ground cloves
1.25 gms ground mace
dash salt
60 gms raisins

Spice Round Cake (continued)

Directions: Preheat Toaster oven at 176.6°C for 2½ minutes. Grease and flour a 1.425 l loaf pan. Cream together butter, sugar and egg at low speed of mixer. Add molasses and milk, mix thoroughly. Blend in flour, soda, nutmeg, cloves, mace, and salt. Beat 3 minutes at medium speed of electric mixer. Fold in raisins. Spread batter in prepared loaf pan. Cover loosely with metal foil. Place pan directly on toaster rack. Bake 30 minutes at 176.6°C. Remove foil. Continue baking for 15 minutes, or until cake tests done. Slide control knob down to OFF position. Remove cake from oven and cool 10 minutes on a rack, then remove from pan. Serve with whipped cream or fresh fruit topping.

Yield: Seventeen 1 cm pieces.

Note: When using a glass baking pan, set temperature at 176.6°C and bake 20 minutes after foil is removed.

COOKING WITH METRICS (2)

You need:

a metric cooking thermometer

metric measuring utensils

a hot plate

ingredients for recipe

a 39.6 x 26.7 x 2.54 cm pan (15½" x 10½" x 1")

a 1.90 l sauce pan

EXPERIMENT

Using the following recipe, mix and cook the ingredients according to the metric units. Pull and eat the taffy!

Salt Water Taffy (Converted from Better Homes and Gardens New Cook Book, 1974, page 94)

500 gms granulated sugar
250 ml light corn syrup
7.5 gms salt
30 gms butter or margarine
1.25 ml oil of peppermint
7 drops green food coloring

Directions: Combine sugar, syrup, salt, and 250 ml water in 1.90 l sauce pan. Cook slowly, stirring constantly, till sugar dissolves. Cook to hard ball stage (129.4° C) without stirring. Remove from heat; stir in remaining ingredients. Pour into buttered 39.6 x 26.7 x 2.54 cm pan. Cool until comfortable to handle. Butter hands; gather taffy into a ball and pull. When candy is light in color and gets hard to pull, cut into fourths, pull each piece into long strand about 1.25 cm thick. With buttered scissors quickly snip bite-size pieces. Wrap each piece in wax paper. Makes 566 gms.

For your information:

Candy States

	Temperature of Syrup (F) Fahrenheit	Centigrade
Thread	230-234 degrees	110-112 degrees
Soft ball	234-240 degrees	112-115.5 degrees
Firm ball	244-248 degrees	117.6-120 degrees
Hard ball	250-266 degrees	121.1-130 degrees
Soft crack	270-290 degrees	132.2-143.3 degrees
Hard crack	300-310 degrees	148.8-154.4 degrees

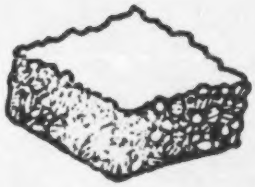
COOKING WITH METRICS (3)

You need:

- $23\ cm^2$ baking dish
- Cutting board
- Foil
- Ingredients for 'Munchy Squares'

EXPERIMENT

Using the following recipe, mix and bake the ingredients:



Munchy Squares

100 g butter or margarine, melted

100 g packed brown sugar

75 g honey

830 g 100% natural cereal

Method:

Mix butter, honey, brown sugar over low heat until smooth.
Pour mixture over cereal and stir well.
Pack firmly into foil lined $23\ cm^2$ baking dish.
Bake at 232° C (450° F) for 6-8 minutes.
Cool, turn dish over on cutting board.
Remove dish and foil.
Cut into desired sizes
Yield: Maximum 40 pieces

COOKING WITH METRICS (4)

You need:

Ingredients for "After Lunch Peppermit Crunch"

Wax paper 30 cm x 50 cm

Bowl for mixing

EXPERIMENT

Follow the "After Lunch Peppermit Crunch" recipe to obtain practice in cooking with metric units. This recipe does not give exposure to Celsius temperature readings.

After Lunch Peppermint Crunch

2-227 g packages of softened cream cheese

228 g powdered sugar

200 g crushed peppermint candy

2-4 m red food coloring

Method:

Use a piece of waxed paper 30cm by 50 cm.
Place some powdered sugar on the paper.
Dip your clean fingers of one hand into the sugar.
Use the other hand to take a bite-sized spoonful of mixture out of spoon and roll on sugar.
Flatten with palm of hand into 2 or 3 cm peppermints.

Yield: Approximately 50 mints

kitchen conversion chart

1 drop = 1 drop
1 teaspoon = $5cm^3$ also c.c. or ml
1 tablespoon = $15cm^3$ also c.c. or ml
1/4 cup = 60ml
1/3 cup = 80ml
1/2 cup = 125ml
1 cup = 250ml
2 cups = 500ml
3 cups = 750ml
4 cups = 1,000ml (1 litre)

1 cup of granulated sugar weighs about **250 grams**

1 cup confectioners sugar weighs about **150 grams**

1 cup brown sugar weighs about **200 grams**

1 cup of molasses, honey or syrup weighs about 375 **grams**

1 teaspoon of cornstarch weighs about **30 grams**

an ordinary egg (average) weighs about 60 **grams**

7 tablespoons of butter weigh about **100 grams**

11 tablespoons of all-purpose flour weigh about 100 **grams**

7 tablespoons of sugar weigh about **100 grams**

about 8 average bananas weigh a **kilogram**

The coldest spot in your freezer is about minus thirty degrees **Celsius** (**C**).

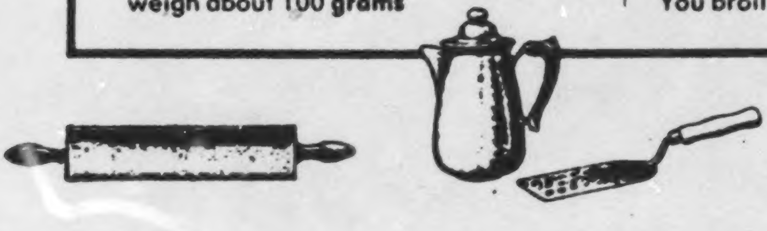
The average temperature in the freezer is around minus twenty degrees **C**.

Water freezes at 0 degrees and boils at 100 degrees **C**.

A slow oven is 130 degrees **C**.
A moderate oven is 180 degrees **C**.

You do deep-fat frying at 190-200 degrees **C**.

A hot oven will be 240-260 degrees **C**.
You broil at 285-290 degrees **C**.



CHAPTER SIX

TEACHER AIDS

INTRODUCTION

A number of supplementary activities are provided in this chapter for the teacher. They explore all the concepts of the metric system and are arranged according to grades, starting from kindergarten and ending with grade twelve and adult education.

There is also an extensive list of references and other resource materials with addresses of where to obtain them included.

m³
Kg
cm
l
m
cm³
ml
g

TEACHER AIDS

HOW TO GO METRIC IN THE CLASSROOM?

Go slowly at first. When it comes time to replace books, maps, and other items, replace them with metric items.

Don't forget the "old" system completely. 1961 Fords and Grandma's cookbooks won't vanish when HR 11035 gets through Congress.

Metric education should be interdisciplinary. Where ever measurement is used, try to use the metric system.

Teach the basic metric terms only at first. Teach the prefixes separate from the base units at first. There are only six important new terms to learn.

Provide a chance for Mom and Dad to learn right along with the kids. Try to encourage thinking metric in the home.

Use the estimation/verification (guess and measure) method in class and at home.

Be sure that the students understand base ten and the decimal system before you start teaching prefixes.

Don't use conversion factors with the students. They should be used as an aid for the teacher in finding common items for examples.

Use the dollar as an example of the metric system, comparing the dollar to the meter, the dime to the decimeter, the cent to the centimeter and the mill to the millimeter.

Kindergarten

Informal Measurement

Linear (line distance): K-M-L

I. Units: No formal units.

II. Concepts: Objects differ in length, height, or distance. Familiarity with the language is most important at this time.

III. Activities: Compare two to five objects by length.

Compare two distances between objects.

Straight-line distances should be compared since children's perception at this level attends only to the ending or highest point.

Introduce the following terms with gross differences apparent: long, short; tall, short; long, longer, longest, same length; tall, taller, tallest, same height; near, far.

Capacity (filling): K-M-C

I. Units: No formal units.

II. Concepts: Containers differ in their capacity. Familiarity with the language of fluid measurement is important.

III. Activities:

Fill containers of different capacities (boxes, cups, cylinders, tubs).

Compare amounts by pouring back and forth.

Introduce terms with marked differences in sizes of containers: more, less, more, most; less, least; full, empty.

Area (surface covering):

I. Units: No formal units.

II. Concepts: Shapes vary in size. Language of measurement of area should be introduced informally.

III. Activities: Similar shapes, varying only one attribute (surface), should be used when introducing: large, small; larger, largest; smaller, smallest; the same.

Volume (solid object):

K-M-V

I. Units: No formal units.

II. Concepts: Objects vary in volume. Language of volume should be introduced informally.

III. Activities: Using solid objects such as kindergarten blocks, have pupils indicate which piece contains more or less wood. Use only blocks of similar shape with clear difference. Comparative labelling of the amount should be informal.

Mass (heaviness):

K-M-M

I. Units: No formal units.

II. Concepts: Objects vary in mass. Language of measurement of mass should be introduced informally.

III. Activities: Compare mass by feel, by lifting and handling.

Compare two or three objects to determine differences. Marked differences should exist since the objective of this experience is to introduce the language of heavy, heavier, heaviest; light, lighter, lightest.

Temperature:

I. Units: None. No specific reference to thermometer.

II. Concepts: Temperature varies.

III. Activities: No activities. However, the comparative vocabulary should be introduced: hot, hotter; warm, warmer; cold, colder.

First Grade

Informal Measurement

Linear (line distance): 1-M-L

I. Units: None.

II. Concepts: Distances can be compared. Distances can be measured in many ways. The concept of number should be associated with units of informal measurement.

III. Activities: The pupils will state or record the number of units (blocks, books, chalkboard erasers, sticks, boxes, all of uniform size, and filling the distance solidly), necessary to measure the distance. The number of nonstandard units should be limited to approximately 20 and be visible to the pupils. Reintroduce the comparison vocabulary of K-M-L: long, tall, short, same length (or height), etc.

Capacity (filling): 1-M-C

I. Units: None

II. Concepts: One container holds more than another container, less than another container, or the same amount.

III. Activities: Activities should be informal and involve pouring, filling, exchanging amounts, etc., with jars, tubs, bottles, tubes, boxes, and so on. Both liquid and dry materials for filling should be available.

The vocabulary of K-M-C should be continued in use.

Comparison of gross differences should be used with the vocabulary.

Area (surface covering): 1-M-A

I. Units: None

II. Concepts: Some shapes are the same size and some are bigger than others; some are smaller then others; areas may be compared. The concept of counting the number of nonstandard units should be associated with surface covering.

III. Activities: Counting the number of stamps, tiles, squares of paper it takes to cover a page or space.

Comparisons of like plane geometric shapes varying only in size should be used with the vocabulary of larger, largest; smaller, smallest.

Volume (solid objects): 1-M-V

I. Units: None

II. Concepts: Volumes may be compared.

III. Activities: Seriate several solids of like shapes, varying only in one dimension: height or width or length.

Reinforce vocabulary of more, less.

Mass (heaviness): 1-M-M

I. Units: None

II. Concepts: Some objects are heavier than others. They may be compared.

III. Activities: Place three or four objects in order by how heavy they feel. The differences should be gross, so that the concept is apparent.

Temperature (change in thermometer): 1-M-T

I. Units: None

II. Concepts: A change in the thermometer occurs when it gets warmer or colder.

III. Activities: Will the thermometer "go up" or "go down": In hot water? In cold water? In sunlight? In shade?

Test and observe change.

Set up a model of the thermometer and adjust it "up" or "down" as compared to a previous observation.

Note to teacher: Estimation has been delayed until the second level in order to distinguish it from "guessing." For children to make "educated guesses" they must have some prior experience with materials in the environment. If pupils have had that experience, estimation should be introduced at the first level.

Second Grade

Linear (distance); 2-M-L

I. Units: Centimeter, decimeter, meter (the only formal units prior to the third level).

II. Concepts: Units are arbitrary.

The need exists for standard units.

Estimates help check the reasonableness of measures.

One meter may be divided into 100 centimeters, and there are 10 centimeters in 1 decimeter.

III. Activities: Measure a distance in non-standard units.

Develop need for standard units. Compare measures by hand, foot, etc.

With a ruler marked in 1-centimeter division, count and record the number of centimeters from one point to another.

Estimate, record, and verify distances up to 30 cm.

Mark a ruler from 0 to 30 centimeters when given a line scored with 1-centimeter spaces.

Mark off a stick in centimeters.

Construct a measuring stick 10 decimeters long. Subdivide each dicimeter into centimeters.

Record distance measurements in meters.

Note to teacher: Provide many experiences to develop the relationship of the units: centimeter ←——→ decimeter ←——→ meter. Clearly establish standard metric relationships in linear measurement before introducing metric measurement in area or volume.

Capacity (filling): 2-M-C

I. Units: No specific units.

II. Concepts: Units are arbitrary.

Units must be uniform in amount.

There can be a relationship between non-standard units.

III. Activities: Compare smaller to larger units by means of non-standard uniform units; e.g., 3 small cans fill 1 large can.

Using cups, find out how many it takes to fill a pre-marked container.

Compare and fill larger containers, recording the number of smaller units in the larger one; i.e., the pail contains five of the smaller containers.

Using one container as a unit, record the capacity of familiar containers (milk carton, coffee can, jars).

Relabel familiar containers with unit lines; i.e., 1/2 can, 1 can, 1 1/2 cans, etc.

Estimate the volume of new containers, record, and verify.

Note to teacher: Do not introduce specific units. Make direct comparisons between the containers themselves.

Area (surface covering): 2-M-A

I. Units: None

II. Concepts: Area means surface by units.

Units are arbitrary.

Units must be uniform.

Units may be interrelated.

Identify larger and smaller regions.

III. Activities: Estimate the number of non-standard units (stamps, tiles, paper squares) to cover a given surface. Record estimate. Cover area and check with estimate.

Use a variety of rectangular shapes with equal total areas. Rearrange the shapes in many different configurations, noting area on each arrangement.

Volume (solid objects): 2-M-V

I. Units: None

II. Concepts: Identify gross differences in volume.

III. Activities: Estimate which is greater or more, record.

Compare similar solid shapes (e.g., blocks) with one dimension altered.

Seriate shapes by volume.

Mass (heaviness): 2-M-M

I. Units: None

II. Concepts: Units are arbitrary.

Units must be uniform to be meaningful.

Units can have an interrelationship.

III. Activities: Compare several items: guess which is heavier or heaviest, record, and verify on a balance scale.

Develop a set of non-standard mass units.

Balance items with a non-standard set of mass units such as tiles or blocks. The use of a balance scale is maintained in order to physically compare the mass of an object to that of a non-standard set of mass units.

Estimate mass of objects in order; record, and verify.

Find mass of packaged foods in non-standard units and relabel them.

Temperature (Celsius): 2-M-T

I. Units: Degree Celsius

II. Concepts: Temperature can be measured.

Differences in temperature can be identified.

III. Activities: Read and record daily temperatures in degrees Celsius.

Guess temperature and record guess daily (after having experience of the first activity on which to base an estimate).

Given two substances, identify which is hotter or colder. Repeat activity with several pairs.

Graph changes in temperature in degrees Celsius (use term informally).

Third Grade

Linear (distance): 3-M-L

I. Units: Centimeter, decimeter, meter.

II. Concepts: Distance can be divided into standard units of length.

Standard units can be used to communicate distance.

III. Activities: Estimate and record distances in the room, schoolyard, and community, using centimeter, decimeters, and meters.

Introduce metric instruments--rulers, meter sticks, metric tapes, and trundle wheels--commercial and student-made.

Using a metric ruler, measure and record the length of lines in centimeters.

After having used centimeter measurement, estimate, record, measure, record, compare.

Measure perimeters of rectangular plane figures.

Develop relationships between centimeters, decimeters, and meters.

Note to teacher: At this grade level and hereafter, area will be treated following linear measure because of the measuring relationship sequence: Linear (length) ⟶ Area (length x width) ⟶ Volume (length x width x height).

Area (surface covering) 3-M-A

I. Units: Square centimeters, square decimeters, and square meters.

II. Concepts: Standard units are needed to communicate.

The choice of an appropriate unit is related to the size of the area to be measured.

Standard units are introduced: 1-10-100

III. Activities: Estimate the number of non-standard units (stamps, tiles, paper squares, file cards) to a given surface, and record. Cover area and record actual count. Compare results.

Using metric graph paper on which regular polygons are transposed, count the units of area.

Using metric graph paper, transpose irregular shapes (leaves, handprints, foot shapes) and count the units of area.

Use rectangular arrays on metric graph paper and describe area as two sets of five squares, or five sets of two squares. Keep areas small. Introduce along with early multiplication facts.

Volume (solid objects): 3-M-V

I. Units: None

II. Concepts: Volume can be divided into uniform units.

III. Activities: Introduce the term cubic unit with blocks.

Compare a large rectangular prism with a small regular block. How many square blocks are contained in the larger one? Estimate, record, construct a model, count, record, compare results.

Capacity (filling): 3-M-C

I. Units: Liter

II. Concepts: Standard units are necessary to communicate measure.

III. Activities: Fill boxes with smaller boxes as units to develop a non-standard unit system of measurement.

Fill boxes with blocks to count the capacity and volume.

Following introductory experiences to provide basis for estimating, provide many containers for filling; estimate, record, and verify.

Introduce the term liter. Fill familiar liquid containers and mark with liter lines.

Note to teachers: Provide just a brief exposure to volume of solid objects at the introductory level. However, much time should be spent with the capacity concept. Though volume and capacity have a definite relationship, that of "filling," the units are labelled differently--i.e., a volume of one cubic decimeter has the capacity of one liter.

Mass (heaviness): 3-M-M

I. Units: Gram, kilogram

II. Concepts: Standard units are necessary to communicate measure.

Units can have an interrelationship.

The choice of an appropriate unit is related to the mass of the objects.

III. Activities: Using standard metric mass units and a balance scale, estimate, record, and verify the mass of small objects.

Build a set of metric mass units by filling, comparing, and labelling a set of cans or boxes.

Introduce the spring scale and verify it with the set of metric mass units.

Introduce the bathroom scale for kilograms.

Develop the relationship between grams and kilograms.

Temperature (Celsius): 3-M-T

I. Units: Degree Celsius.

II. Concepts: Temperature changes may be measured with different scales.

III. Activities: Record temperature in degrees Celsius and degrees Fahrenheit.

Determine the approximate freezing temperature of water and boiling points of water on each scale.

Fourth Grade

Linear (distance): 4-M-L

I. **Units:** Centimeter, decimeter, meter

II. **Concepts:** Measurement is an approximation.

III. **Activities:** Estimate and measure distances in centimeters and meters to the nearest unit. Apply appropriate basic unit.

Label common distances.

Introduce and apply metric tools such as the trundle wheel, tapes, calipers, map wheels for greater precision.

Compare metric units with feet and inches for common distances.

Reinforce standard unit relationship.

Area (surface covering): 4-M-A

I. **Units:** square centimeters, square meters.

II. **Concepts:** Using graph paper, estimate the area of small regions.

Select appropriate unit for regions.

Continue to use physical models of areas. Fill area with square centimeter or square meter units.

Rearrange triangles and parallelograms into rectangular shapes and estimate number of square units of area.

Within rectangles, fill one row lengthwise and one row of width. Estimate area. Build on multiplication array.

Volume (solid space filling): 4-M-V

I. **Units:** Cubic centimeter, cubic decimeter.

II. **Concepts:** Models can be built to represent objects.

Volume can be computed by counting, adding, or multiplying.

III. **Activities:** Construct various prisms with cubic centimeters. Count the units needed.

Construct regular rectangular prisms, counting the number of units per row, the number of rows per level, and the number of levels. Compute the total unit volume by counting, adding, and multiplying.

Capacity (liquid filling): 4-M-C

I. Units: Centiliter, liter

II. Concepts: There is a relationship between volume and capacity--liquid filling vs. solid-space filling.

The units of capacity and volume are related.

III. Activities: Relate volume and capacity by constructing and filling familiar household containers with dry ingredients (sand, rice, meal) labelling cubic centimeters and liters, showing volume units are similar.

Restate cubic decimeters as liters.

Mass (heaviness): 4-M-M

I. Units: gram, kilogram

II. Concepts: Common food items can be sold by mass units.

The unit of measure chosen depends on the amount of an item being measured.

III. Activities: Continue to build relationship of grams to kilograms.

Relabel standard grocery items in grams and in halves or quarters of a kilogram.

Restate halves and quarters of kilograms as grams.

Estimate, record, verify masses in grams and kilograms.

Temperature (Celsius): 4-M-T

I. Units: Degree Celsius.

II. Concepts: Temperature may be measured with different scales (same as grade 3).

III. Activities: Continue to record daily temperatures and experimental temperatures in degrees Celsius and degrees Fahrenheit.

Develop parallel pictures and parallel thermometer models.

Fifth Grade

Linear (line distance): 5-M-L

I. **Units**: millimeter, centimeter, decimeter, meter, kilometer.

II. **Concepts**: Metric units have a decimal relationship.

Perimeter is a linear measurement.

III. **Activities**: Estimate distances; select appropriate unit; verify estimate.

Restate distances in several different units to show understanding of decimal relationship.

Emphasize use of millimeter as fine measurement unit.

Area (surface covering): 5-M-A

I. **Units**: Square centimeter, square meter.

II. **Concepts**: Metric units have decimal division.

Area may be expressed as length times width.

III. **Activities**: Reinforce multiplication-array approach by estimating area in appropriate units, measuring the sides, and computing.

Verify some answers by plane space filling.

Subdivide large units into smaller units.

Restate area in larger units.

Relate perimeter, as linear measurement, to area.

Volume (space filling); 5-M-V

I. **Units**: Cubic centimeter, cubic decimeter, cubic meter.

II. **Concepts**: Volume may be expressed as length times width times height.

III. **Activities**: Build on length times width area relationship of one layer and count number of layers to model volume unit concept.

Extend with concrete models length times width times height.

Develop the generalized rule for volume of rectangular prisms length times width times height.

Capacity (liquid filling): 5-M-C

I. Units: Milliliter, centiliter, liter.

II. Concepts: Units of capacity are decimally related.

III. Activities: Estimate capacity of containers, record, fill, and verify.

Select appropriate units for containers, of various sizes.

Restate capacity in various units.

Restate cubic decimeter as a liter.

Mass (heaviness): 5-M-M

I. Units: Centigram, gram, kilogram.

II. Concepts: Metric measures have multiples and sub-multiples.

III. Activities: Estimate mass of objects in grams or kilograms, record, and verify.

Select appropriate unit for estimated mass of object.

Restate mass of objects in various metric units.

Temperature (Celsius); 5-M-T

I. Units: Degree Celsius

II. Concepts: Both Celsius and Fahrenheit scales use freezing point and boiling point as bench marks (though the levels on each scale are different).

III. Activities: Estimate, in degrees Celsius, temperatures for weather conditions, record, and verify.

Apply temperature in science experiments.

Compare from memory a Celsius and Fahrenheit thermometer showing freezing point and boiling point of water on each.

Sixth Grade

At the sixth grade level, extend the system of units, but continue to emphasize the common units.

Linear (line distance): 6-M-L

I. Units: Millimeter, centimeter, decimeter, meter, kilometer.

II. Concepts: The source of basic metric units is the meter.

English and metric units relate.

Decimal extension of metric units.

III. Activities: Know scientific source of the unit meter.

Extend estimation, recording, verifying in the five unit divisions.

Compare centimeters and inches, centimeters and feet, yards and meters.

Express measure in other metric units; e.g., 10 cm = 1 dm

Area (surface covering): 6-M-A

I. Units: Square millimeters, square centimeters, square decimeters, square meters.

II. Concepts: Metric units extend decimally in area.

III. Activities: Extend estimation, recording, and verifying in all units.

Extend multiplication-array approach in area.

Compare areas with square units in centimeters and inches.

Express measure in other metric units; e.g., 100 cm^2 = 1 dm^2.

Volume (space filling): 6-M-V

I. Units: Cubic millimeters, cubic centimeters, cubic decimeters, cubic meters, cubic kilometers.

II. Concepts: Metric units extend decimally in volume.

III. Activities: Extend models of volume with cubic units (Length times width times height).

Reinforce generalized rule for computing volume by multiplying length by width by height to calculate the number of cubic units.

Compare objects in metric units with English units; e.g., cubic feet to cubic centimeters.

Express measure in other metric units; e.g., 1000 cm^3 = 1 dm^3.

Capacity (liquid filling); 6-M-C

I. Units: Milliliter, centiliter, deciliter, liter, kiloliter.

II. Concepts: No new concepts--decimal relationship extended.

III. Activities: Estimate capacity in milliliters, centiliters, deciliters, and liters of containers, record, verify.

Select appropriate units.

Compare capacity of containers in metric units to common English units; e.g., liter to quart.

Express amounts in other metric units.

Mass (heaviness): 6-M-M

I. Units: Milligram, centigram, decigram, gram, kilogram.

II. Concepts: No new concepts--decimal relationship extended.

III. Activities: Estimate mass of objects in metric units, record, and verify.

Select appropriate units of mass for objects.

Compare mass of objects in English and metric units.

Using the same objects, state masses in various metric units.

Temperature (Celsius); 6-M-T

(Extend as in Grade 5.)

GRADES K - 2

The measurement unit should be a readiness program. The need for standard units of measurement should be developed as it has regularly been done in preparing to teach the English system. Opportunities for the students to measure length, capacity, mass and temperature should be given.

To measure length, sticks or rods with a length of 1 m and 10 cm should be available and sticks or rods with a length of 1 cm and 20 cm might also be available. No marks of any other kind indicating smaller units should be placed on these rods. Cuisenaire rods may be used.

To measure capacity, a cylinder and/or beaker and/or liter box should be available (no names or smaller units should be indicated) with plenty of bottles and boxes in which foods or materials are packaged that students have seen in the store or have at home. Beans or sand or water should be available for the students to pour back and forth from one container to another.

For mass, and I do believe "mass" should be used in preference to "weight," a balance scale with mass pieces should be available with many articles (again, with which the students are familiar) like rolls of scotch tape, candy bars, tooth brushes, and bars of soap. Articles should be used on the balance scale to balance each other or balance the standard mass pieces. More pieces can be made out of modeling clay. Homemade balance scales could be used.

When temperature is being taught, instead of using a scale marked in degrees, paper could be cut out to cover the scale simply indicating room or air temperature such as cold, cool, warm and hot. This might be indicated on the paper by shades of red; for instance, white for cold, pink for chilly, brighter pink for warm and red for hot.

I do not believe it appropriate to include much terminology, names of units and symbols at this level, although I am certain that there are some students with whom such material could be used very successfully.

Provide many opportunities for students to approximate (guess) length, capacity and mass.

GRADES 3 - 8

For students in grades 3 through 8, a sequence of material should be presented considering content, concepts and skills that would be appropriate at that level. Care must be taken to assure that multiplication by ten, one hundred, one thousand, one-tenth, one-hundredth, and one-thousandth can be performed before introducing conversion within the Metric System that requires the knowledge of such skills.

An activity approach is definitely needed. Much opportunity must be provided for measurement of length, capacity, mass and temperature with provision made for the inclusion of perimeter, area, and volume at an appropriate time. Line segments drawn on paper for students to approximate and then measure the length of must be accurate. Figures representing large dimensions should be drawn to scale and the fact that this has been done should be indicated. Bags of sand or beans should be provided for students to hold and guess the mass of. Perhaps different materials should be used so that the difference in mass cannot be determined by appearance.

New terminology should be introduced a sufficient number of times that the terms become a part of the child. According to the Independent Reading Association, a child needs to read, write, speak, hear or use a word 28 times before this occurs. There can be fill-in-the blanks, scrambled words, letter arrays, spelling lists, matching....

Each time a unit is introduced some point of reference should be provided for the student so that he can think of and/or visualize that reference each time a unit is used. For example: one millimeter - the thickness of a dime; one gram - about the mass of one M & M; one kilometer - nine and one quarter times around a baseball field. Practical applications should be provided for the student whenever possible. These applications will no doubt take the form of verbal problems. Skills required in the solution of such problems should be simple enough that students weak in these skills will not experience frustration and, thus, associate this frustration with the Metric System.

The decimal system of numeration should be introduced at an earlier level than is now customarily done. Students need the experience of reading and writing quantities and working with quantities expressed in multiples of ten and submultiples of ten.

Metric kits can be made by each student which include a piece of string (or yarn) 1 meter long, a cardboard strip 10 cm long, and flattened straws cut into 1 cm lengths. A centicube or paperclip which has a mass of 1 gram can be included. The names of the units and their symbols can be written on separate pieces of cardboard and kept in the kit for matching games or "show me" games.

An interesting activity could be correspondence with a "sister school," especially if that school is in Canada, England, Japan, Germany...so that questions, problems and applications could be traded. This also provides an opportunity for togetherness (the class works as a group in composing the letter) in this age of individualization.

GRADES 9 - 12

The amount that needs to be taught to students at this grade level would depend on their background, particularly in science. If the Metric System is new to the students or if previous knowledge has been forgotten, then the same approach should be used with these students as those in grades 3 - 8.

ADULTS

For most adults, experiences with the Metric System they have previously had will no doubt have been forgotten. Therefore, an approach like that used with high school students is recommended.

ALL LEVELS

At all levels it is appropriate for students to make their own models of the meter, liter, and milliliter. Perhaps even models of the gram and kilogram could be made using modeling clay. Students should be asked to find present-day uses of the Metric System (pharmacy, photography, sports...) and talk to persons in varied careers to see if and how the Metric System will be used.

With students at all ages, I would recommend a comprehensive unit of measurement where all phases of the Metric System that are to be introduced that year would be introduced. Teachers would provide follow-up throughout the year with weekly metric activities. Learning stations could be provided. Whenever verbal problems are used, one involving metric units should be included.

It is necessary for the general consumer to work only with length (meter), capacity (liter), mass (kilogram), and temperature (degree Celsius). To work with luminous intensity (candela), amount of substance (mole), electric current (ampere) is not appropriate for most persons at that level.

There are three important aspects of the Metric System that every person studying it should understand:

(1) It is a decimal system.
(2) The same prefixes are used with every base unit, except the kilogram where the prefixes are added to gram.
(3) There is a relationship between length, capacity and mass.

IN-SERVICE TRAINING FOR TEACHERS AND COURSES AT TEACHER TRAINING INSTITUTIONS

Teachers usually teach the way they have been taught. Therefore, teachers should have the same activity approach as they will be using in their classrooms. They, too, should have a chance to make models of the meter, decimeter, centimeter and use their own models before using commercial models for measuring familiar things. The same is true for the liter and milliliter cubes or boxes. Lumps of clay used to make mass pieces of 500 grams, 100 grams, and one gram could be used. A feel for temperature using the Celsius scale should also be developed.

USE OF MULTI-MEDIA MATERIALS

Filmstrips, tapes, and films should be available for use along with printed material. All such media should be previewed so that its value as introductory, integral, or review will be determined with appropriate activities developed. It is to be remembered that distances and sizes will be distorted on the screen when filmstrips, film loops or films are used. Therefore, these materials alone are not sufficient to teach the Metric System.

METRIC LEGISLATION

Until the federal government passes a bill, many persons will be reluctant to teach the Metric System. There are so many industries, however, that are committed to the Metric System that it behooves us to teach it even prior to that time. Students and adults, particularly those that are history oriented, would be interested in writing to state and/or to federal legislators to obtain proposed bills and/or resolutions. Copies of research reports done by the National Bureau of Standards would be valuable and should be provided at each high school and each LEA media center.

The community should be involved wherever appropriate. Local radio stations and/or TV stations could be requested to give weather conditions using metric units. Towns might include speed limit and distance signs in metric units. PTA programs and programs for civic organizations could be provided by interested citizens.

RESEARCH

Little research has been completed to show the "best way" to teach the Metric System, but there seems to be total agreement on two points. (1) The approach must be activity oriented and (2) the Metric System must be taught with no conversion between Metric and English units being included.

Research is being planned to see what effect parent involvement might have on student achievement and attitude. I believe that this could be very valuable.

A proposal for a research grant has been submitted to the National Institute of Education to further the research with parent involvement and to give students a chance to do "parent-tutoring."

SUMMARY

In summary, I can only suggest that those persons teaching any age group be familiar with content, and approach the unit of measurement with a positive attitude and with enthusiasm and vigor!

CONTENT INFORMATION

The spelling of names of units and the symbols of same will undoubtedly be those recommended in NBS Special Publication 330, "The International System of Units (SI)." The symbol SI comes from the French "Le Systeme International d' Unités."

All You Will Need to Know About Metric

(For Your Everyday Life)

10

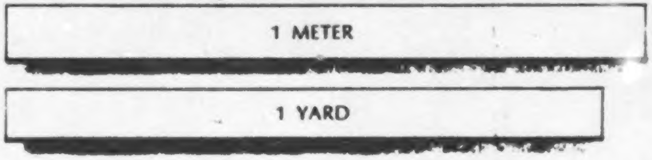
Metric is based on Decimal system

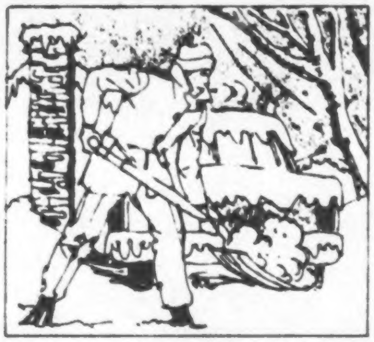
The metric system is simple to learn. For use in your everyday life you will need to know only ten units. You will also need to get used to a few new temperatures. Of course, there are other units which most persons will not need to learn. There are even some metric units with which you are already familiar: those for time and electricity are the same as you use now.

BASIC UNITS

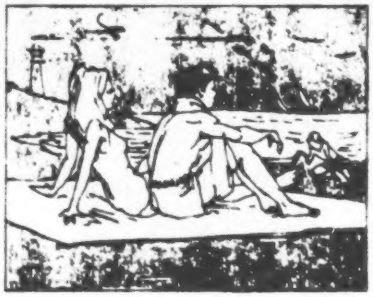
METER:	a little longer than a yard (about 1.1 yards)
LITER:	a little larger than a quart (about 1.06 quarts)
GRAM:	about the weight of a paper clip

(comparative sizes are shown)





25 DEGREES FAHRENHEIT



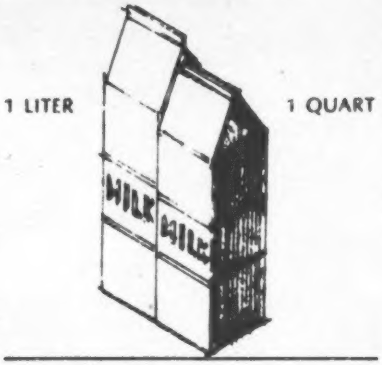
25 DEGREES CELSIUS

COMMON PREFIXES
(to be used with basic units)

Milli:	one-thousandth (0.001)
Centi:	one-hundredth (0.01)
Kilo:	one-thousand times (1000)

For example:

1000 millimeters = 1 meter
100 centimeters = 1 meter
1000 meters = 1 kilometer

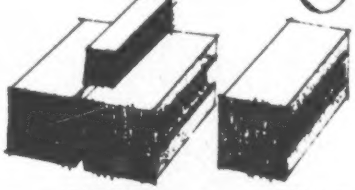


OTHER COMMONLY USED UNITS

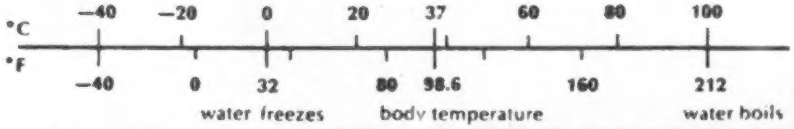
Millimeter:	0.001 meter	diameter of paper clip wire
Centimeter:	0.01 meter	width of a paper clip (about 0.4 inch)
Kilometer:	1000 meters	somewhat further than ½ mile (about 0.6 mile)
Kilogram:	1000 grams	a little more than 2 pounds (about 2.2 pounds)
Milliliter:	0.001 liter	five of them make a teaspoon

OTHER USEFUL UNITS

Hectare: about 2½ acres
Tonne: about one ton



TEMPERATURE
degrees Celsius are used



For more information, write to: Metric Information Office, National Bureau of Standards
Washington, D.C. 20234

Note: This chart may be reproduced

METRIC REFERENCES

Meters, Liters, and Grams: A Study of the Metric System. Red book and blue book. Audrey Buffington. New York: Random House, 1973. (64 pages)

Metric Measurement: Activities and Bulletin Boards. Cecil R. Trueblood. Dansville, New York: Instructor Curriculum Materials, 1973. (43 pages)

The Metric System of Measurement. Verde Holmberg, Hayward, Calif.: Activity Resources Co., Inc., 1973. (98 pages)

Practice in the Metric System. Dansville, N.Y.: The Instructor Publications, 1973. (20 pages)

Working with Color Rods in Metric Measurement: Metric Length, Metric Area, and Metric Volume. Joseph P. Cech and Carl Seltzer. Skokie, Ill.: National Textbook Company, 1973. (21 pages)

The Metric Center. Ada Booth, Palo Alto, Calif.: Enrich, 1973.

Metric Power: Why and How We are Going Metric. Richard Deming. New York: Thomas Nelson, 1974. (144 pages) $5.95.

Metric Math: The Modernized Metric System (SI). James R. Smart. Monterey, Calif.: Brooks/Cole Publishing Co. Inc. 1974.

Metric Measure, books A and B. New York: Harcourt Brace Jovanovich, Inc., 1974.

The Metric System and Teacher's Edition. Menlo Park, Calif.: Addison-Wesley, 1974.

A Metric Handbook for Teacher's. Higgins, Beston, Va.: National Council of Teachers of Math, 1974.

METRIC FILMSTRIPS/GAMES

"Metric Weights and Measures". 1973. Wichita, Kansas: Library Filmstrip Center. $21.00 with record and $23.00 with casette.

"Metric Measurement: Activities in Capacity, Mass, and Temperature" The Math Group. 1974. $3.50.

Metric "21", card game. The Math Group, Inc., Minneapolis, 1974. $1.80.

RESOURCE MATERIAL

Free Materials:

1. Ford Motor Co.
   Educational Affairs Dept.
   The American Road
   Dearborn, Mich. 48121

   Chart: "A History of Measurement"

2. General Motors Corporation
   Public Relations Staff
   General Motors Building
   Detroit, Mich. 48202

   Booklet: "Precision: A Measure of Progress"

3. Greenfield Tap and Die
   Greenfield, Mass. 01301

   Chart: "Decimal Equivalents and Comparisons of Inch with Other Standard Measurement Systems"

4. National Aerospace Education Council
   Room 310, 806 15th Street NW
   Washington, D.C. 20005

   Booklet: "Measure for Measure"

5. The Cooper Group
   P.O. Box 728
   Apex, N.C. 27512

   Booklet: "The Amazing Story of Measurement"

6. U.S. Department of Commerce
   National Bureau of Standards
   Washington, D.C. 20234

   Booklet: "Some References on Metric Information"
   Gives listings on materials available from the NBS and other sources for metric materials.

7. McDonalds Restaurants (not all of the branches will have these)

   Folder: "McDonaldland and the McMetric System"

Catalogs:

1. Metric Association Inc.
   Sugarloaf Star Rt.
   Boulder, Colorado 80302

   Metric Training Aids (Price List)

2. National Council of Teachers of Mathematics
   1201 16th St., N.W.
   Washington, D.C. 20036

   Organizations Marketing Metric Materials for Educators

3. Metric Aids
   75 Horner Ave.
   Tornonto, Canada

   Metric Aids: A Catalog of Materials for Metric Teaching Aids

4. Spectrum
   1151 Mainland Street, Ste. 315
   Vancouver, B.C., V6B 2T9

   Metric Teaching Aids

5. Educational Teaching Aids
   657 Oak Grove Plaza
   Menlo Park, CA 94025

   Metric Teaching Aids

6. Metric Studies Center
   American Institutes for Research
   Box 1113
   Palo Alto, CA 94302

   Catalog of Metric Instructional Materials ($1.50 if payment accompanies order)

More Materials:

1. Things of Science, Dept. 3-73, Science Service
   1719 N. St., N.W.
   Washington, D.C. 20035

   "Things of Science--Metric System"
   --available for $1.00

2. National Science Teachers Association
1201 16th St., N.W.
Washington, D.C. 20035

"Measurement and the Metric System" ($3.00)
"Metric Exercises" ($6.00) -- 50¢ postage and handling

3. Teachers
P.O. Box 398
Manhattan Beach, CA 90266

"Early Childhood Metric Fun Book" -- primary	$4.95
"Fun With Metric Measurement" -- intermediate	$4.95
"Metric Fun Activity Cards: Set A 1-4"	$4.95
"Metric Fun Activity Cards: Set B 3-9"	$4.95

The top two are activities that can be copied for classroom use. All four are excellent sources for metric activities and can be bought and used as a building set. There is a handling cost.

4. Milliken Publishing Co.
St. Louis, Missouri

Metric System Series, 28 duplicating masters, D 3.75

MS01	Metric System	Bk. 1	1-2 gr.
MS02	Metric System	Bk. 2	3-4 gr.
MS03	Metric System	Bk. 3	5-6 gr.

Very good activities and worksheets.

5. Creative Publications
P.O. Box 10328
Palo, Alto, CA 94303

Metric Posters: Set of 4 "It's a Metric World, Think Metric, World Records, and History of Measurement" $5.75 #61000

The posters are very colorful and interesting. Creative publications has other metric materials available--ask for a catalog.

Filmstrips:

A metric America

Metrication of America

The above are sets of metric filmstrips both containing a filmstrip on the history of the metric system as well as length, weight or mass, volume, and temperature.

Metric Olympics -- a kit containing dittos for activities, activity cards and a filmstrip.